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Environmental Impact Report for the Lower Klamath Project License Surrender Volume I

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Water Boards
STATE WATER RESOURCES CONTROL BOARD
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Draft Environmental Impact Report for the Lower Klamath Project License Surrender

Volume I

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The Lower Klamath Project License Surrender Draft Environmental Impact Report is being made available to the public in accordance with the California Environmental Quality Act. Public Comments are due on Tuesday, February 26, 2019.

Visit Lower Klamath Project License Surrender Project Web Site (https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/low er_klamath_ferc14803.shtml) where you can:

- View and download an electronic copy of the Draft EIR.
- View or download a list of libraries and other locations where hardcopies of the Draft EIR are available for review.

To receive future email notifications regarding the Lower Klamath Project, please subscribe to the “Lower Klamath Project License Surrender” email subscription list under “Water Rights”.
Instructions on how to sign up for the State Water Board’s Email Subscription List are outlined below:

1. Visit: http://www.waterboards.ca.gov/resources/email_subscriptions/swrcb_subscribe.shtml#rights
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3. In the categories below the email and name fields, select “Water Rights,” then “Lower Klamath Project License Surrender.”
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ACRONYMS AND ABBREVIATIONS

2010 BiOp Flows	NMFS 2010 Biological Opinion
2012 KHSA EIS/EIR	Klamath Facilities Removal EIS/EIR
2013 BiOp Flows	NMFS and USFWS 2013 Joint Biological Opinion
AADT	Annual Average Daily Traffic
AB	Assembly Bill
AF	Acre-feet
amsl	Above mean sea level
AR	Aquatic Resource
ATWG	Aquatic Technical Work Group
BiOp	Biological Opinion
BOD	Biochemical Oxygen Demand
BLM	Bureau of Land Management
BMI	Benthic Macroinvertebrates
BMPs	Best Management Practices
BP	Before Present
ºC	Degrees Celsius
CAAQS	California Ambient Air Quality Standards
CalEPA	California Environmental Protection Agency
CALFIRE	California Department of Forestry and Fire Protection
CalRecycle	California Department of Resources Recycling and Recovery
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CBOF	Carbonaceous Biochemical Oxygen Demand
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cfs	Cubic feet per second
CGS	California Geological Survey
CH_4	Methane
CNDDB	California Natural Diversity Database

CNEL	Community Noise Equivalent Sound Level
CNPPA	California Native Plant Protection Act
CNPS	California Native Plant Society
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COPCs	Chemicals of Potential Concern
CRPR	California Rare Plant Rank
CWA	Clean Water Act
CY	cubic yards
dB	Decibels
dBA	A-weighted Decibels
DOC	California Department of Conservation
DOI	Department of the Interior
DPS	Distinct Population Segment
DTSC	California Department of Toxic Substances Control
DRE	Dam Removal Entity
DWR	California Department of Water Resources
EDR	Environmental Data Sources, Inc.
EFH	Essential Fish Habitat
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ENSO	El Niño Southern Oscillation
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
EWA	Environmental Water Account
°F	Degrees Fahrenheit
Ftm	Fathoms
FEIR	Final Environmental Impact Report
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
GCM	Global Circulation Model
GHG	Greenhouse Gas
GIS	Geographic Information System
gpm	Gallons per minute

GWP	Global Warming Potential
HCP	Habitat Conservation Plan
HFCs	Hydrofluorocarbons
HTRW	Hazardous, Toxic, and Radioactive Waste
IBI	Index of Biological Integrity
IDP	Inadvertent Discovery Plan
IFR	Institute for Fisheries Resources
IOD	Immediate Oxygen Demand
IM	Interim Measure
KBRA	Klamath Basin Restoration Agreement
KBRA Flows	Klamath Irrigation Project
KDR	Klamath Dam Removal
KDRM	Klamath Dam Removal Model
KHHD	Klamath Hydroelectric Historic District
KHSA	Klamath Hydropower Settlement Agreement
KOP	Key Observation Point
KRRC	Klamath River Renewal Corporation
L_{dn}	Day-night average sound Level
L_{eq}	Equivalent Sound Level
LiDAR	Light Detection And Ranging
L_{max}	Maximum Sound Level
L_n	Percentile-exceeded Sound Level
LOS	Levels of Service
LVPP	Looting and Vandalism Prevention Program
mgd	Million gallons per day
mg/L	Milligram per liter
MLPA	California Marine Life Protection Act
MMRP	Mitigation Monitoring and Reporting Program
MSAE	*Microcystis aeruginosa*
msl	Mean Sea Level
MW	Megawatts
MWh	Megawatt-hours
MWMT	Maximum Weekly Maximum Temperatures
Mya	Million Years Ago
N_2O	Nitrous Oxide

NAAQS	National Ambient Air Quality Standards
NCAB	North Coast Air Basin
NCCP	Natural Community Conservation Planning
NEPA	National Environmental Policy Act
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NMFS	National Marine Fisheries Service
NNE	Nutrient Numeric Endpoints
NOAA	National Oceanic and Atmospheric Administration
NOP	Notice of Preparation
North Coast Regional Board	North Coast Regional Water Quality Control Board
NOx	Nitrogen
NPAB	Northeast Plateau Air Basin
NPS	National Park Service
NRC	Natural Research Council
NRCS	Natural Resources Conservation Service
NVCP	Noise and Vibration Control Plan
NWR	National Wildlife Refuge
NWS	National Weather Service
O_3	Ozone
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OEHHA	Office of Environmental Health Hazard Assessment
ORV	Outstandingly Remarkable Values
OWRD	Oregon Water Resources Department
PAH	Poly-cyclic Aromatic Hydrocarbon
PBDE	Polybrominated Diphenyl Ether
PCB	Polychlorinated Biphenyl
PCE	Primary Constituent Elements
PCFFA	Pacific Coast Federation of Fisherman's Associations
PFCs	Perfluorocarbons
PM	Particulate Matter
ppt	Parts Per Trillion
PPV	Peak Particle Velocity

RM	River Mile
ROD	Record of Decision
ROG	Reactive Organic Gases
RSET	Regional Sediment Evaluation Team
RV	Recreational Vehicle
RWS	Reservoir Water Surface
SHPO	State Historic Preservation Officer
SEF	Sediment Evaluation Framework
SF_6	Sulfur Hexafluoride
SLV	Screening Level Value
SONCC	Southern Oregon/Northern California Coast
SSC	Suspended Sediment Concentration
STAGE	Siskiyou Transit and General Express
State Water Board	State Water Resources Control Board
SO_2	Sulfur Dioxide
SOD	Sediment Oxygen Demand
SRP	Soluble Reactive Phosphorus
SSC	Suspended Sediment Concentrations
s.u.	Standard units
SVOC	Semi-volatile Organic Compound
SWAMP	Surface Water Ambient Monitoring Program
SWPPP	Stormwater Pollution Prevention Plan
TAC	Toxic Air Contaminant
TCR	Tribal Cultural Resource
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TNM	Traffic Noise Model
TP	Total Phosphorus
TRMP	Tribal Resources Management Plan
TSS	Total Suspended Solids
UGB	Urban Growth Boundary
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency

USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VdB	Vibration decibels
VOC	Volatile Organic Compound
VRI	Visual Resource Inventory
VRM	Visual Resource Management
WECC	Western Electricity Coordinating Council
WHO	World Health Organization
WQ Plan	Water Quality Monitoring Plan
WRIMS	Water Resources Integrated Modeling System
WSR	Wild and Scenic River
WSRA	Wild and Scenic Rivers Act
WY	Water Year

EXECUTIVE SUMMARY

On September 23, 2016, the Klamath River Renewal Corporation (KRRC) applied to the Federal Energy Regulatory Commission (FERC) to remove the dams and associated facilities that together form the Lower Klamath Project (FERC Project No. 14083). The KRRC's goal is to create a free-flowing Klamath River and provide for volitional fish passage in the Klamath River currently occupied by the Lower Klamath Project. The Lower Klamath Project consists of four dams: (J.C. Boyle; Copco No. 2; Copco No. 1; and Iron Gate) and their associated facilities (e.g., powerhouses, penstocks and power lines). The Lower Klamath Project (FERC Project No. 14803) is currently part of the Klamath Hydroelectric Project (FERC Project No. 2082), which is owned and operated by PacifiCorp. The Klamath Hydroelectric Project also includes several additional hydropower facilities (e.g., Fall Creek, East Side, West Side and Keno).

Also on September 23, 2016, the KRRC applied to the California State Water Resources Control Board (State Water Board) for water quality certification for the Proposed Project, pursuant to section 401 of the Clean Water Act. The State Water Board's water quality certification addresses water quality in California. The State Water Board is the lead agency for the California Environmental Quality Act (CEQA), which requires analysis of the environmental impacts of projects that can affect the environment. This Environmental Impact Report (EIR) was prepared to conform with CEQA. It focuses primarily on impacts related to actions proposed for the California portion of the Proposed Project. Actions at the J.C. Boyle Dam complex, located in Klamath County, Oregon, and other actions of the Proposed Project in Oregon, are described in general terms, but the discussion of actions in Oregon are limited to those with the potential to adversely impact the California environment. Oregon's Department of Environmental Quality issued a separate water quality certification for the Proposed Project that addresses water quality impacts in Oregon, including removal of the J.C. Boyle Dam complex. FERC and other federal agencies will analyze impacts of the Proposed Project in both states.

Proposed Project Location

The Lower Klamath Project is located on, and adjacent to, the Klamath River in Siskiyou County, California, and in Klamath County, Oregon (Figure ES-1). The State Water Board has identified the Project Boundary as inclusive of the Proposed Project "Limits of Work", as well as PacifiCorp owned and managed lands immediately surrounding the Lower Klamath Project ("Parcel B lands"), that would be transferred as part of the Proposed Project (Figure ES-2). The nearest city to the California portion of the Proposed Project is Yreka, which is located 20 miles southwest of the downstream end of the Proposed Project. The California portion of the Proposed Project includes the following three dams and associated facilities: Copco No. 1 Dam (River Mile [RM] 201.8), Copco No. 2 Dam (RM 201.5), and Iron Gate Dam (RM 193.1). For purposes of analyses conducted in this EIR, the California portion of the Klamath River system has been divided into four (4) reaches as follows: Hydroelectric Reach, Middle Klamath River, Lower Klamath River, and Klamath River Estuary (Figure ES-1).

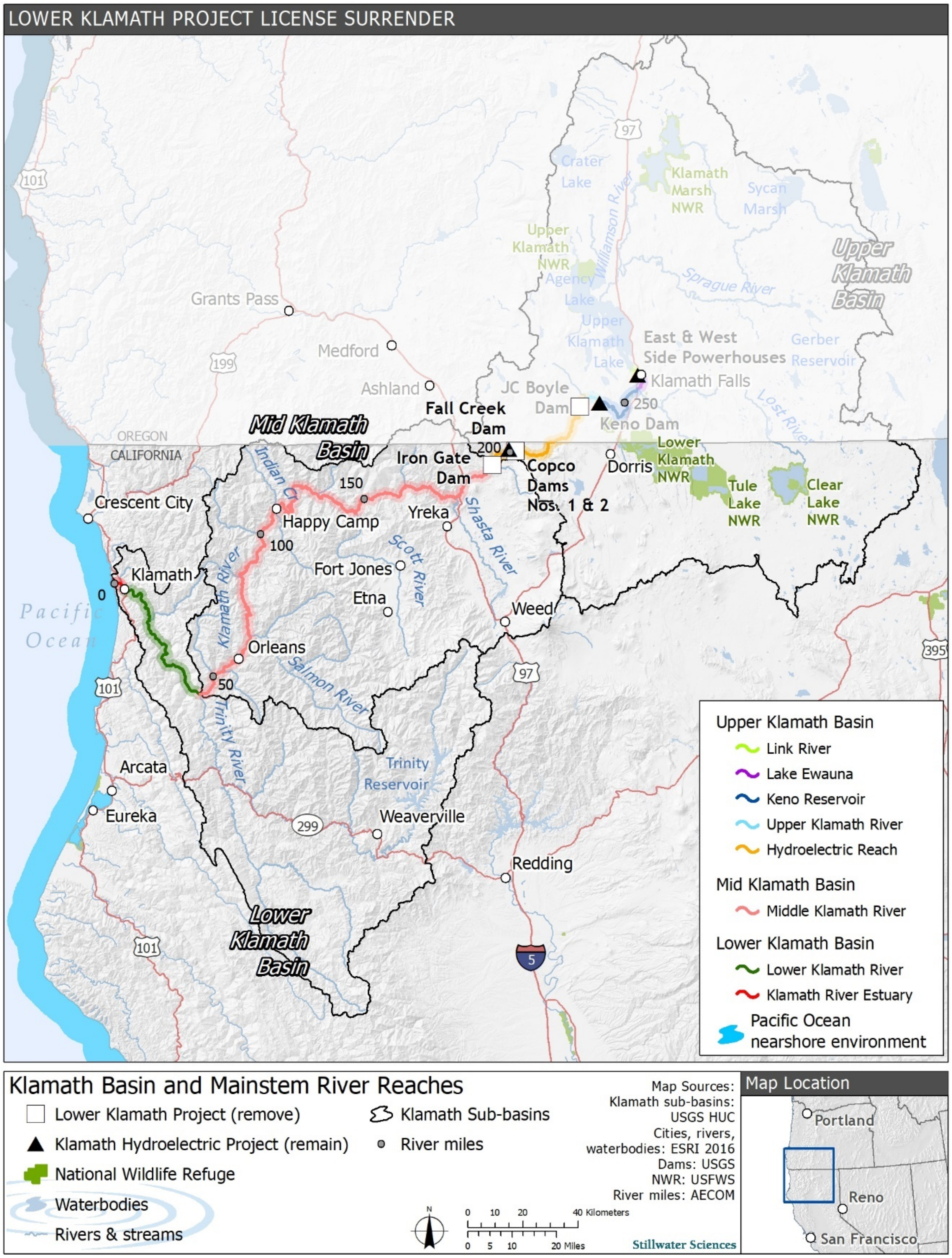

Figure ES-1. Klamath Basin and Mainstem River Reaches.

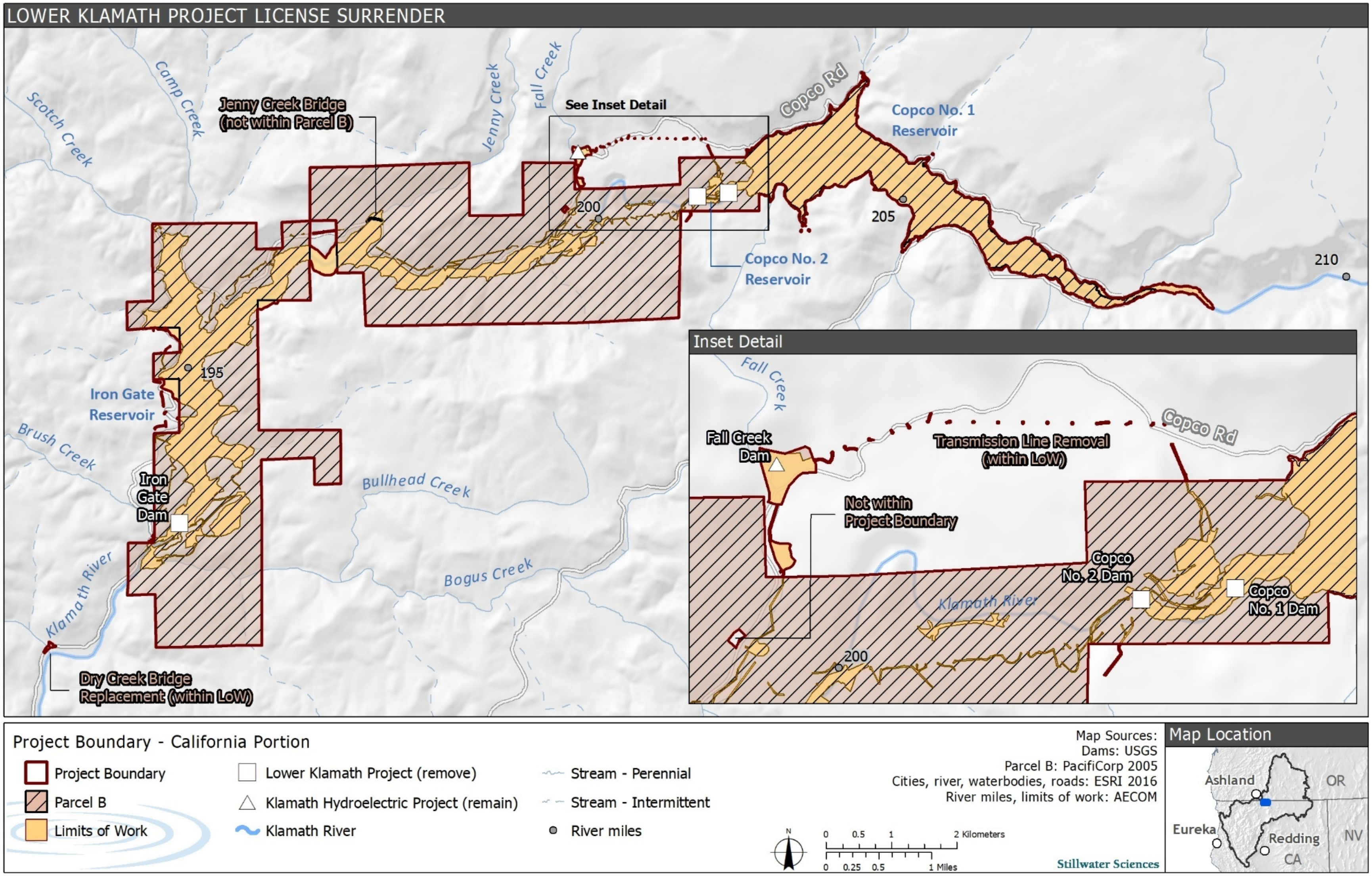

Figure ES-2. Proposed Project Boundary – California Portion.

Proposed Project Objectives

The State Water Board has identified the following Proposed Project objectives, as required under CEQA Guidelines, section 15124, subdivision (b):

In a timely manner:

1. Improve the long-term water quality conditions associated with the Lower Klamath Project in the California reaches of the Klamath River, including water quality impairments due to *Microcystis aeruginosa* and associated toxins, water temperature, and levels of biostimulatory nutrients.
2. Advance the long-term restoration of the natural fish populations in the Klamath Basin, with particular emphasis on restoring the salmonid fisheries used for subsistence, commerce, tribal cultural purposes, and recreation.
3. Restore volitional anadromous fish passage in the Klamath Basin to viable habitat currently made inaccessible by the Lower Klamath Project dams.
4. Ameliorate conditions underlying high disease rates among Klamath River salmonids.

The objectives further the underlying purpose of the Proposed Project, which is the timely improvement of water quality related to the Lower Klamath Project within and downstream of the current Hydroelectric Reach and the restoration of anadromous access upstream of Iron Gate Dam (the current barrier to anadromy).

Proposed Project

Dam and Powerhouse Deconstruction

The Proposed Project includes the deconstruction of the J.C. Boyle Dam and Powerhouse, Copco No. 1 Dam and Powerhouse, Copco No. 2 Dam and Powerhouse, and Iron Gate Dam and Powerhouse, as well as associated features. Associated features vary by powerhouse, but generally include: powerhouse intake structures, embankments and sidewalls, penstocks and supports, decks, piers, gate houses, fish ladders and holding facilities, pipes and pipe cradles, spillway gates and structures, diversion control structures, tunnels, aprons, sills, tailrace channels, footbridges, powerhouse hazardous materials, transmission lines, switchyards, a remnant cofferdam near Copco No. 2 Dam, portions of the Iron Gate Fish Hatchery, and various buildings. To access the dams for deconstruction, the KRRC would perform a controlled reservoir drawdown using both existing and modified infrastructure. Dam demolition would occur over approximately four months using multiple techniques, including blasting and hydraulic excavators. In addition, road maintenance, improvements and rehabilitation; culvert replacements; and bridge protection, strengthening, or replacement, would occur at numerous locations within the Proposed Project Limits of Work to support construction activities.

Anticipated import materials include gravel, sheetpile or H-piles, topsoil, seed and mulch materials, ready-mix concrete, reinforcing steel, mechanical equipment materials for the road, bridge and culvert improvements/replacements, and signage. Staging areas and disposal sites would also be created for each of the dams within the Proposed Project Limits of Work, and offsite waste disposal would likely be hauled to the Yreka Transfer

Station (Class III sanitary landfill). Hazardous materials would be handled and disposed of in accordance with applicable regulations.

Reservoir Drawdown

Copco No. 1 Reservoir would be drawn down first (November–March of dam removal year 1)[1], followed by J.C. Boyle (Oregon) and Iron Gate reservoirs (January–March of dam removal year 2). Copco No. 2 Reservoir is substantially smaller than the other three dams and the KRRC proposes to drawdown this reservoir after Copco No. 1 Dam has been breached to final grade in May of dam removal year 2. The proposed drawdown period was designed to: (1) balance the water quality impacts of dam removal across different life stages of aquatic species in the Middle and Lower Klamath River reaches; (2) use naturally high winter flows to flush sediments trapped in the reservoirs as quickly as possible; and (3) permit power generation revenues for the period specified in the Klamath Hydroelectric Settlement Agreement (KHSA). For all reservoirs, the minimum drawdown rate would be two feet per day, and the maximum drawdown rate would be five feet per day, until drained.

The maximum average flow releases would be: 138 cfs at J.C. Boyle Dam (Oregon), 762 cfs at Copco No. 1 Dam, and 822 cfs at Iron Gate Dam. These releases correspond to three percent, 13 percent, and 14 percent of the two-year peak flow in the Klamath River, and one percent, seven percent, and six percent of the 10-year peak flow in the Klamath River, respectively. These maximum rates would occur during dry periods, with slower drawdown (lower flow releases) occurring during storm events. During Iron Gate Dam removal, the embankment dam crest would be retained at a level to accommodate the passage of a 100-year flood event.

Power generation at Copco No. 1 Dam would end after the reservoir reaches the minimum operating level at reservoir surface elevation 2,604.5 feet, in November of dam removal year 1. If power generating equipment proves capable under sediment-laden conditions, power generation at Copco No. 2 Dam could continue until May of dam removal year 2. At J.C. Boyle (Oregon) and Iron Gate dams, power generation would cease on January 1 of dam removal year 2.

Reservoir Sediment Deposits and Erosion During Drawdown

There would be an estimated 15.1 million cubic yards (14.6 million tons) of sediment stored in the J.C. Boyle, Copco No. 1, and Iron Gate reservoirs by 2020 (USBR 2012). Between 2020 and 2021 (i.e., dam removal year 2, when drawdown is anticipated to primarily occur) the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so the 2020 sediment volumes provide a reasonable estimate for 2021 and thus for the Proposed Project. Copco No. 2 Reservoir does not retain

[1] The Proposed Project schedule is broken down into calendar years: pre-dam removal years 1−3, dam removal year 1, dam removal year 2, and post-dam removal years 1 through 10. See Table 2.7-1 for detailed schedule of Proposed Project activities.

appreciable amounts of sediment, because of its smaller size and location, and would not appreciably contribute to sediment transport during the drawdown of the reservoirs.

Approximately 85 percent of the sediment stored behind the reservoirs is fine (silt and clay), which would be easily eroded during drawdown, and only approximately 15 percent is coarse (sand and larger). Approximately 36 to 57 percent of the total sediment stored in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs by 2021 is expected to be eroded and transported downstream during the drawdown period and the year following dam removal (i.e., short-term), which is equivalent to 5.4 to 8.6 million cubic yards (1.2 to 2.3 million tons). The range in the estimated volume of sediment eroded from each reservoir is primarily dependent upon whether the prevailing hydrology during reservoir drawdown corresponds to a dry hydrologic year or a wet hydrologic year, with less erosion expected in a dry year. The majority of the erosion would occur during the reservoir drawdown process and would be a combination of direct erosion of sediment by moving water, slumping of the fine sediment along the reservoir sides toward the river, and sediment jetting of some areas of reservoir-deposited sediments during drawdown. The short-term (i.e., two years following dam removal) effects of the Proposed Project on dam-released sediment and sediment resupply would likely extend from Iron Gate Dam to approximately Cottonwood Creek (USBR 2012). Most of the fine sediment is expected to be transported in suspension to the ocean shortly after being eroded. Fine sediment erosion would result in elevated suspended sediment concentrations downstream of Iron Gate Dam in the short term (Stillwater Sciences 2010, USBR 2012). Coarse sediment transport would occur more slowly and would be dependent on the frequency and magnitude of mobilizing flows and attenuation by channel storage.

Restoration within the Reservoir Footprint

The following sequence describes the activities that would be implemented in the former reservoir footprints to manage remaining sediment deposits and restore habitat.

- *Pre-dam removal* (pre-dam removal year 3, and dam removal year 1): collect and propagate seed and control invasive plants.
- *Reservoir drawdown* (January to March, dam removal year 2): revegetate exposed reservoir areas during and following drawdown by hydroseeding with a pioneer seed mix that contains common native plant species and sterile wheat mixed with a mycorrhizal inoculant and is capable of dealing with poor soil conditions, inclement weather, and complex hydrology, and by installing acorns, shrub seedlings, and pole cuttings. Permanent wildlife-friendly cattle exclusion fencing would be installed around the reservoir restoration areas where they abut grazing lands prior to drawdown, or shortly after the pioneer seeding.
- *Post-drawdown first summer/fall* (dry season immediately after drawdown during dam removal year 2): monitor and rectify any non-natural fish passage barriers, conduct additional fall overseeding on exposed areas, install riparian trees and shrubs, and install an irrigation system in the Bank Riparian Zone that would provide water for the duration of the KRRC maintenance and monitoring period.
- *Post-dam removal* (post-dam removal year 1): maintain vegetation, continue to remove and treat invasive exotic vegetation, install floodplain and off-channel habitat features, such as large wood. Monitor and rectify any non-natural fish passage barriers in mainstem and tributaries.

- *Establishment period* (post-dam removal years 2 through 5): continued monitoring and maintenance of vegetation, removal of invasive exotic vegetation, fish passage monitoring, and enhancement of habitat features as needed.
- *Long term* (post-dam removal years 5 through 10): continued monitoring and adaptive management, removal of invasive exotic vegetation, and fish passage monitoring. Vegetation restoration would be monitored for five years, or until the relevant performance criteria associated with minimizing invasive exotic vegetation, enhancing native plant diversity, and survival of planted trees and shrubs, have been met.

Restoration of Upland Areas Outside of the Reservoir Footprint

The following activities would be implemented in upland areas outside of the reservoirs' footprints:

- *Pre-dam removal:* active management of invasive exotic vegetation, which may include grazing, manual weed extraction, solarization (covering ground areas with black visqueen), tilling, and use of herbicides. Additionally, native plants would be prepared by collecting seeds and working with local nurseries to grow trees and shrubs.
- *Construction/deconstruction period*: protection of native trees.
- *Post-dam removal*: restoration of upland disposal, staging, temporary access, infrastructure demolition, and former recreation areas, including activities such as addressing compaction and broadcast-seeding with a native seed mix. Soils would be disked and ripped in preparation for planting. A temporary irrigation system may be installed in upland areas, if required.

Fish Hatcheries

During demolition, some Iron Gate Hatchery facilities located at the base of Iron Gate Dam would be removed, along with the cold-water supply and aerator for the hatchery. However, operational components of Iron Gate Hatchery would be retained and modified to continue operations at a reduced rate for just Chinook salmon and to eliminate coho salmon production. The nearby Fall Creek Hatchery, located at Fall Creek just upstream of Iron Gate Reservoir, would be reopened to maintain the current Iron Gate coho salmon production and some Chinook salmon production. The Iron Gate and Fall Creek hatcheries would remain in operation for eight years following removal of the dams, at which point the hatcheries would cease operations

City of Yreka Water Supply Pipeline Relocation

The City of Yreka receives its water supply from Fall Creek, a tributary to the Klamath River in the Upper Klamath Basin, approximately 23 miles northeast of the City of Yreka. At the upstream end of Iron Gate Reservoir, the pipeline crosses the reservoir and is minimally buried in the reservoir bed. To prevent damage to the pipeline, a replacement pipe crossing would be installed before dam removal and reservoir drawdown. The replacement pipe crossing would consist of one of the following three options:

- A new buried pipeline by micro-tunneling in the immediate vicinity of the existing pipeline crossing.

- A new aerial pipeline on a dedicated utility pipe crossing in the immediate vicinity of the existing pipeline crossing.
- A combination of a new buried pipeline and an aerial pipeline crossing on the existing timber traffic bridge along Daggett Road located approximately 2,000 feet upstream of the existing pipeline crossing.

Other Project Components

Other Proposed Project components include:

- ***Aquatic Resource Measures*** – surveys and protection measures for mainstem spawning and outmigrating juveniles; delayed release of hatchery fish from Iron Gate Fish Hatchery to avoid poor water quality; and surveys and relocation of suckers and freshwater mussels.
- ***Terrestrial Resource Measures*** – stabilization of remaining sediments and restoration of reservoir and other disturbed areas for habitat restoration; and surveys and avoidance and minimization measures for nesting birds, bald and golden eagles, special-status bats, northern spotted owl, and special-status plants.
- ***Transportation and Traffic*** – improve roads, bridges and culverts affected by the Proposed Project construction and ongoing maintenance.
- ***Recreation*** – implementation of a Recreation Plan, which includes removal of numerous existing recreation facilities, and restoration with native vegetation before, during and after dam removal at J.C. Boyle Reservoir, Copco No. 1 Reservoir, Iron Gate Reservoir, and dispersed recreation sites; initiates process to add new river-based recreation opportunities.
- ***Downstream Flood Control*** – maintain existing flood protection.
- ***Management and Other Plans*** – Cultural Resources Plan, Traffic Management Plan, Water Quality Monitoring Plan, Groundwater Well Management Plan, Fire Management Plan, Hazardous Material Management Plan, Emergency Response Plan, and Noise and Vibration Control Plan.

Land Disposition

Before dam removal, PacifiCorp would transfer most of the lands immediately surrounding the Lower Klamath Project ("Parcel B lands") to the KRRC. The Proposed Project provides that, after dam removal, the KRRC would transfer Parcel B lands to California or Oregon or to a designated third-party for public interest purposes, as described under KHSA Section 7.6.4.

Summary of Proposed Project Effects, Potential Impacts, and Potential Cumulative Impacts

Table ES-1 (located after the Executive Summary *References*) summarizes the potential impacts examined in this EIR. For each potential impact, it lists the significance of the potential impact for the Proposed Project (and for each of the alternatives analyzed), and whether these potential impacts would be short term or long term. The table also notes mitigation measures that could reduce the severity of potentially significant impacts.

The largest number of adverse impacts under the Proposed Project would be impacts due to reservoir drawdown (and the resulting sediment discharge) and from dam removal activities; however, many of these impacts would be reduced through proposed mitigation for the resource areas listed above. Additionally, many of these impacts would be short term. Mitigation measures are listed in Table ES-1. All mitigation measures would be included in a Mitigation, Monitoring, and Reporting Program (MMRP).

Effects with No Significant Impact (with or without Mitigation)

As shown in Table ES-1, most of the potential impacts assessed in this EIR would result in no significant impact or no significant impact with mitigation. The Proposed Project itself, or the Proposed Project with proposed mitigation measures, would result in no significant impact for one or more impacts in all resource areas.

Effects Found to be Beneficial

A summary, by resource area, of effects found to be beneficial for the Proposed Project is provided below. These effects are also summarized in Table ES-1, along with effects found to be beneficial for the alternatives.

Water Quality

- Short-term and long-term water temperature improvements in the Hydroelectric Reach and the Middle Klamath River to the confluence with the Salmon River;
- Short-term and long-term elimination of summer and fall extremes in dissolved oxygen concentrations in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam;
- Short-term and long-term decreases in summer and fall pH and daily pH fluctuations in the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam; and
- Short-term and long-term reduction of chlorophyll-a and algal toxins for the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary.

Aquatic Resources

- Long-term effects on in coho salmon critical habitat quality and quantity;
- Long-term effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality and quantity;

- Long-term beneficial effects on the fall-run Chinook salmon population due to increased habitat quality and quantity;
- Long-term beneficial effects on the spring-run Chinook salmon population due to increased habitat quality and quantity;
- Long-term beneficial effects on the coho salmon population due to increased habitat quality and quantity;
- Long-term beneficial effects on the steelhead population due to increased habitat quality and quantity;
- Long-term beneficial effects on the Pacific lamprey population due to increased habitat quality and quantity;
- Long-term beneficial effects on the redband trout population due to increased habitat quality and quantity;
- Short-term and long-term beneficial effects on species interactions between introduced resident fish species and native aquatic species due to short- and long-term changes in habitat quality and quantity; and
- Long-term beneficial effects on benthic macroinvertebrate habitat quality.

Phytoplankton and Periphyton

- Long-term change in the spatial extent, temporal duration, transport, or concentration of nuisance and/or noxious phytoplankton blooms and concentrations of algal toxins in the Hydroelectric Reach, Middle and Lower Klamath River, and Klamath River Estuary.

Terrestrial Resources

- Long-term beneficial effects on riparian habitat downstream of the Lower Klamath Project due to sediment deposition and the creation of new surfaces for colonization;
- Long-term beneficial effects on willow flycatcher from additional riparian habitat in the former location of Copco No. 1 and Iron Gate reservoirs;
- Long-term beneficial effects on special-status amphibians and reptiles in riverine habitats from improved water quality;
- Long-term beneficial effects on benthic macroinvertebrates due to increased habitat availability and improved habitat quality;
- Long-term beneficial effects on deer from an increase in winter range habitat;
- Long-term beneficial effects on rare natural communities, wetlands, and riparian vegetation from herbicide use during reservoir restoration that would improve habitat conditions by reducing competition from invasive species;
- Effects on wildlife from increased habitat for salmonid spawning, production, and migration and increase in prey and overall nutrient distribution;
- Long-term effects on wildlife from increased wildlife movement opportunities; and
- Long-term effects on terrestrial wildlife from an increase in the distribution of salmon-derived nutrients upstream of Iron Gate, Copco No. 1 and Copco No. 2 dams.

Flood Hydrology

- Long-term decrease in the risk of dam failure resulting in flooding of areas downstream of the Lower Klamath Project.

Geology, Soils, and Mineral Resources

- Long-term increase in sediment supply and transport, creating a more dynamic and mobile riverbed within the Hydroelectric Reach and downstream of Iron Gate Dam.

Historical Resources and Tribal Cultural Resources

- Klamath Riverscape Contributing Aspect – long-term beneficial effects on the Klamath River fishery of predicted increases in fish production and health from dam removal and the long-term benefits on much of the key tribal trust species (e.g., Chinook salmon, coho salmon, steelhead, and Pacific lamprey) resulting from improved river ecosystem function and increased habitat access; and
- Klamath Riverscape Contributing Aspect – long-term increase in the ability of tribes to access and use the Middle and Lower Klamath River for ceremonial and other purposes due to improvements in riverine water quality and reductions in seasonal blue-green algae blooms in Copco No. 1 and Iron Gate reservoirs.

Recreation

- Increased recreational fishing opportunities due to increased habitat access for salmonids and improved water quality; and
- Long-term beneficial effects on California Klamath Wild and Scenic River resources due to a return to more natural conditions and improved water quality, and scenic, wildlife, fishery, and recreation river values.

Significant Unavoidable Adverse Impacts

Below is a summary, by resource area, of impacts found to be 'significant and unavoidable' with or without mitigation (Table ES-1). Please note, the KRRC proposes to further develop Proposed Project actions relating to certain state and local regulatory requirements for several resource areas that fall outside of State Water Board's water quality certification authority. The State Water Board anticipates implementation of additional measures (e.g., good neighbor agreements between the KRRC and relevant state or local agencies, recommended measures in this EIR, and any modifications developed through the FERC process that provide the same or better level of protection for the resource in question) would reduce impacts. The EIR notes where such protection would eliminate the potential for a significant impact. However, the State Water Board cannot ensure implementation of good neighbor agreements, recommended measures included in this EIR, or modifications anticipated to be developed through the FERC process. Therefore, the State Water Board has identified impacts that rely on implementation of such agreements or recommended measures in this EIR as significant and unavoidable.

Water Quality

- Short-term increases in suspended sediments in the Hydroelectric Reach, Middle and Lower Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environments due to release of sediments currently trapped behind the Lower Klamath Project dams;
- Short-term increases in oxygen demand and reductions in dissolved oxygen due to release of sediments currently trapped behind the Lower Klamath Project dams in the Hydroelectric Reach and Middle Klamath River from Iron Gate Dam to the Salmon River; and
- Short-term increases in water temperature and reductions in dissolved oxygen in Fall Creek downstream of Fall Creek Hatchery due to hatchery operations.

Aquatic Resources

- Short-term impacts on native freshwater mussels (*Anodonta spp.*) due to elevated suspended sediment concentrations (SSCs) during reservoir drawdown and long-term impacts due to elimination of reservoir habitat in the Hydroelectric Reach and relatively stable flow regime in the Middle Klamath River immediately downstream of Iron Gate Dam.

Phytoplankton and Periphyton

- Potential for short-term and long-term increases in the growth of nuisance periphyton species along the margins of the newly created low gradient river channels in the Hydroelectric Reach.

Terrestrial Resources

- Short-term impacts on special-status plants from construction-related activities within the Limits of Work;
- Short-term and long-term impacts on special-status wetland plants surrounding the reservoirs due to removal of Copco No. 1, Copco No. 2, and Iron Gate reservoirs;
- Short-term impacts on special-status mammals (bats, gray wolf, American badger) from construction-related activities within the Limits of Work;
- Short-term impacts on nesting birds from construction-related noise and habitat removal within and surrounding the Limits of Work;
- Short-term impacts on willow flycatcher from construction-related noise disturbance and habitat removal at Copco No. 1 and Iron Gate reservoirs;
- Short-term impacts on bald and golden eagles from construction-related noise and nesting habitat alterations at Copco No. 1, Copco No. 2, and Iron Gate reservoirs;
- Short- and long-term impacts on special-status bats, maternity roosts, and hibernacula from construction noise and loss of roosting habitat at existing Lower Klamath Project facilities; and
- Short-term impacts on sensitive habitats and special-status terrestrial wildlife and plant species from construction activities on Parcel B lands.

Flood Hydrology

- Long-term change in the Federal Emergency Management Agency (FEMA) 100-year floodplain inundation extent from Iron Gate Dam (RM 193) to Humbug Creek (RM 174), potentially exposing existing structures, which cannot feasibility be moved or elevated, to a substantial risk of flood damage and/or loss.

Air Quality

- Short-term exceedances of the Siskiyou County Air Pollution Control District total daily emissions thresholds for NO_x, PM_{10}, and $PM_{2.5}$[2] during dam removal construction activities.

Historical Resources and Tribal Cultural Resources

- Exposure of or damage to known Tribal Cultural Resources and historic-period archaeological sites through pre-dam removal ground-disturbing construction and disposal activities and increased access to sensitive areas;
- Shifting, erosion, and exposure of known or unknown, previously submerged Tribal Cultural Resources and historic-period archaeological sites, due to reservoir drawdown;
- Erosion or flood disturbance to Tribal Cultural Resources and historic-period archaeological sites located along the Middle Klamath River from Iron Gate Dam to Humbug Creek;
- Physical disturbance of known or unknown tribal cultural resources and historic-period archaeological sites that directly overlap with locations where blasting and other removal techniques would occur;
- Physical disturbance of known Tribal Cultural Resources and historic-period archaeological sites from ground disturbance associated with reservoir restoration, recreation site removal and/or development, disposal site restoration, and ongoing road and recreation site maintenance;
- Increased potential for looting of Tribal Cultural Resources during and following drawdown at Iron Gate, Copco No. 1 and Copco No. 2 reservoirs;
- Exposure or disturbance to known or unknown Tribal Cultural Resources within the reservoir footprints immediately following reservoir drawdown and prior to vegetation establishment/full stabilization of sediment deposits because of erosion caused by high-intensity and/or duration precipitation events;
- Impacts to Tribal Cultural Resources as a result of dam removal from increased looting opportunities and from surface and subsurface erosion of Tribal Cultural Resources;
- Impacts to the historical significance of the Klamath River Hydroelectric Project District due to facilities removal; and

[2] Nitrogen oxides (NO_x), particulate matter with a diameter of 10 microns or less (PM_{10}), and particulate matter with a diameter of 2.5 microns or less ($PM_{2.5}$).

Public Services

- Increases in public service response times for emergency fire, police, and medical services due to construction and demolition activities, including construction-related traffic; and
- Substantial increase in response times for suppressing wildland fires where suitable replacement water sources cannot be identified in close proximity to a fire in a location for which the Lower Klamath Project reservoirs would otherwise have been the nearest water source.

Aesthetics

- Short-term visual changes resulting from reservoir drawdown, including temporarily bare/unvegetated banks;
- Long-term visual changes resulting from new recreation facilities; and
- Short-term impacts to nighttime views in the area from new sources of substantial light or glare from construction or security lighting.

Recreation

- Changes to or loss of river conditions that support whitewater boating in the Hell's Corner reach in the upper portion of the Hydroelectric Reach.

Hazards and Hazardous Substances

- Construction-related traffic may interfere with emergency response on rural roads surrounding the Lower Klamath Project.
- Substantial increase in public's risk of loss, injury or death associated with wildland fires where suitable replacement water sources cannot be identified in close proximity to a fire in a location for which the Lower Klamath Project reservoirs would otherwise have been the nearest water source.

Transportation and Traffic

- Increase in traffic in excess of the capacity or design of the road improvements or impairment of the safety or performance of the circulation system, including transit, roadways, bicycle lanes or pedestrian paths;
- Conflict with an applicable congestion management program for designated roads or highways that would result in increased risk of harm to the public;
- Substantially increasing hazards due to a design feature or incompatible uses associated with construction-related traffic that would result in an increased risk of harm to the public;
- Inadequate emergency access that would result in an increased risk of harm to the public; and
- Conflict of construction-related activities with public transit, bicycle, or pedestrian facilities, or decrease of the performance or safety of such facilities resulting in an increased risk of harm to the public.

Noise

- Short-term exceedance of Siskiyou County General Plan criteria for maximum allowable noise levels from construction equipment;
- Short-term increases in daytime and nighttime noise levels affecting residents near Copco No.1 Dam due to construction activities;
- Short-term increases in nighttime noise levels affecting residents near Iron Gate Dam due to construction activities;
- Short-term increase in noise levels affecting residential areas near Copco No. 1 and Iron Gate reservoirs due to restoration activities;
- Short-term increase in vibration levels affecting residential areas near Copco No.1, Copco No. 2, and Iron Gate dams due to blasting activities during removal of the dams.

There are no significant and unavoidable impacts under the Proposed Project for the following resource areas: groundwater, water supply/water rights, greenhouse gas emissions, geology, soils, and mineral resources, paleontologic resources, land use and planning, agricultural and forestry resources, population and housing, and utilities and service systems.

Cumulative Impacts

CEQA requires determination of whether the combined impact of the Proposed Project and other projects causing related impacts is significant and adverse, and whether the incremental impact of the Proposed Project is cumulatively considerable. Using a list of past, present, and probable future projects within the Klamath Basin, the following impacts are assessed as “cumulatively considerable”:

Water Quality

- Short-term increases in suspended sediments under the Proposed Project in combination with the 2017 court-ordered flushing and emergency dilution flows; and
- Short-term water quality effects of the Proposed Project in combination with wildfires.

Air Quality

- Short-term increases in criteria air pollutant emissions under the Proposed Project in combination with forest and wildfire management projects.

Public Services

- Short-term public services effects from the Proposed Project in combination with non-project activities.

Hazards and Hazardous Substances

- Short-term and long-term hazards (fire-fighting water access) from the Proposed Project in combination with non-project activities.

Transportation and Traffic

- Short-term and long-term traffic and transportation effects from the Proposed Project in combination with non-project activities.

There are no cumulatively considerable impacts for other resource areas.

Alternatives to the Proposed Project

No Project Alternative

The No Project Alternative describes the environment should the KRRC's Proposed Project − to decommission the four dams and associated facilities − not proceed. There is significant uncertainty about the long-term disposition of the Lower Klamath Project facilities if the KRRC's Proposed Project does not proceed.

During the short term (i.e., 0−5 year period), the Lower Klamath Project (i.e., J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities) and the remaining Klamath Hydroelectric Project facilities (East Side, West Side, Keno, and Fall Creek) would continue to operate under annual licenses issued by FERC until the disposition of Lower Klamath Project facilities could be determined through the FERC relicensing process. This would include the potential of another settlement agreement under that process. This timeframe also includes time for completion of any necessary planning or studies to undertake facilities modifications. The current annual license issued for Lower Klamath Project facilities under PacifiCorp's annual FERC licenses for the Klamath Hydroelectric Project (Project No. 2082) has no requirements for additional fish passage or implementation of the prescriptions that are currently before FERC in the Klamath Hydroelectric Project relicensing process.

Additionally, in the short term, the No Project Alternative would not result in any change from the existing management conditions, except regarding flow and certain interim water quality and habitat measures as noted in this paragraph. The 2017 court-ordered flushing and emergency dilution flow releases downstream of Iron Gate Dam (U.S. District Court 2017) would modify flow releases compared to the existing condition. Some KHSA Interim Measures (IMs) would cease.

In addition to the KHSA IMs, there are various efforts in the Klamath Basin to improve water quality, which are discussed in Cumulative Effects (Section 3.24). The effects of these efforts, including efforts aimed at meeting Klamath River total maximum daily loads (TMDLs) are not analyzed for the short term under No Project Alternative because the basin response to the restoration measures to meet the TMDLs during the short term is too speculative.

In the short term, the No Project Alternative would not meet the Proposed Project's underlying objectives. In the long term, the impacts and ability of the No Project Alternative to meet project objectives and purposes are speculative, but they would be within the range of the alternatives and the Proposed Project evaluated in this EIR.

Partial Removal Alternative

In the Partial Removal Alternative, portions of J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities would be removed to ensure a free-flowing Klamath River and year-round volitional fish passage in the Hydroelectric Reach (under all river stages and flow conditions). Ancillary facilities associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dam complexes that do not affect Klamath River flows or volitional fish passage would be secured for public safety (e.g., sealing or fencing to prevent entry, removal of hazardous materials) and abandoned in place. In general, the ancillary facilities to be retained under the Partial Removal Alternative include the Copco No. 1 Powerhouse, penstocks, and intake structure, the Copco No. 2 Powerhouse, steel penstocks and supports, and intake structure, and the lower portion of the Iron Gate Powerhouse, as well as the mechanical and electrical equipment associated with each powerhouse. All other aspects would occur as described under the Proposed Project: dam and powerhouse deconstruction, reservoir drawdown, erosion of reservoir sediment deposits during drawdown, restoration in the reservoir footprint, restoration of upland areas, hatchery operations, City of Yreka water supply pipeline relocation, aquatic and terrestrial resource measures, road and bridge improvements/replacements, culvert replacements, recreation facilities removal, traffic management, groundwater well monitoring and replacement, fire management, hazardous material management, emergency response, and noise and vibration control measures.

This alternative would meet the underlying purpose, and all the objectives, of the Proposed Project. Under the Partial Removal Alternative, the construction footprint would be slightly reduced, and the impact to the historical built environment would be reduced as compared with the Proposed Project. Should this alternative be pursued, the responsibility for long-term maintenance of remaining facilities is unknown.

Continued Operations with Fish Passage Alternative

In the Continued Operations with Fish Passage Alternative, the J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities would be relicensed by FERC for continued operations with changes to allow for upstream and downstream fish passage and updated flow requirements consistent with fishway prescriptions. This alternative would include volitional year-round upstream and downstream fish passage at the dams, and an increase of minimum flows in the J.C. Boyle Bypass Reach and the Copco No. 2 Bypass Reach. Conditions would include flows required by the NMFS and USFWS 2013 Joint Biological Opinion for the Klamath Irrigation Project (2013 BiOp Flows), 2017 court-ordered flushing and emergency dilution flows, and design and implementation of a Reservoir Management Plan. KHSA Interim Measures (IMs) (KHSA Section 1.2.4) would not continue under the Continued Operations with Fish Passage Alternative. Actions consistent with IMs designed for water quality improvements are analyzed in this alternative as part of the Reservoir Management Plan. Additionally, the "California Klamath Restoration Fund/Coho Enhancement Fund" restoration actions, described under the No Project Alternative (see Table 4.2-1), would continue.

This alternative would not meet one of Proposed Project's objectives because it does not adequately address Project-related long-term water quality impairments. It also would only partially further the underlying purpose of the Proposed Project because it would not result in timely improvement of water quality related to the Proposed Project within and downstream of the current Hydroelectric Reach; however, it would further the underlying purpose of providing fish passage upstream of Iron Gate Dam. Because the dams and reservoirs would remain, they would still continue as an impairment to migration that is not present under the Proposed Project. Compared to the Proposed Project, this alternative would avoid potential impacts associated with sediment release, dam removal, and riverine restoration. It would also continue hydropower production at close to existing levels, and it would reduce the level of construction and its associated impacts (as construction activities would mainly be associated with fish ladders rather than dam decommissioning). However, while this alternative would further the underlying purpose and related objectives of providing fish passage upstream of Iron Gate Dam, fish survival through fishways would be reduced as compared to through un-dammed stream reaches. Further, this alternative would not improve other water quality conditions that are stressors for fish and other resources. Thus, this alternative would further the underlying purpose and Proposed Project objectives to some extent, but not to the same extent as the Proposed Project.

Three Dam Removal Alternative

This alternative would remove the three California Lower Klamath Project dams (Copco No. 1, Copco No. 2, and Iron Gate) and associated facilities, but J.C. Boyle Dam and associated facilities would remain in place. J.C. Boyle Dam would operate under the conditions that federal agencies had imposed in the FERC proceedings for the continued relicensing of the Klamath Hydroelectric Project (which is currently on hold). The main changes to J.C. Boyle Dam facilities and operations would be: construction of new fish ladders for upstream and downstream fish passage; new fish screens; elimination of peaking operations; elimination of whitewater recreation flows; changed bypass release requirements; and any conditions imposed by the Oregon Department of Environmental Quality as part of its water quality certification[3] of J.C. Boyle Dam and its associated facilities. The flow-related measures would reduce power generation at J.C. Boyle Dam relative to existing conditions. The alternative assumes that USBR's flow release requirements for Iron Gate Dam would continue to be required as federal Endangered Species Act requirements (i.e., 2013 BiOp Flows and 2017 court-ordered flushing and emergency dilution flows). This alternative considers conditions with and without the 2017 court-ordered flushing and emergency dilution flows for potential impacts related to fish disease.

As compared to the Proposed Project, retaining J.C. Boyle Dam would somewhat reduce the amount and duration of short-term sediment release during reservoir drawdown, although it would not change the determinations of significance or associated mitigation measures. Compared to the Proposed Project, retaining J.C. Boyle Dam results in no meaningful difference in the significance determinations or associated mitigation measures related to construction impacts, because the differing construction efforts would occur in Oregon and any impacts would be substantially diluted in California. This alternative would allow some level of non-peaking hydropower production to continue, but it would be less than under the existing condition or the Continued Operation with Fish Passage Alternative. However, while this alternative would further the underlying purpose and related objectives of providing fish passage, fish survival through fishways would be reduced as compared to passage through un-

[3] This alternative does not make any assumptions about potential Oregon water quality certification conditions.

dammed stream reaches. Thus, the Three Dam Removal Alternative would further the underlying purpose and Proposed Project objectives, but not to the same extent as the Proposed Project.

Two Dam Removal Alternative

This alternative would remove the Copco No. 1 and Iron Gate dams and associated facilities in California, while the J.C. Boyle Dam in Oregon and the Copco No. 2 Dam in California would remain in place. J.C. Boyle Dam would operate under the conditions that federal agencies had imposed in the FERC proceedings for the continued relicensing of the Klamath Hydroelectric Project (which is currently on hold). The main changes to J.C. Boyle facilities and operations would be: construction of new fish ladders for upstream and downstream fish passage; new fish screens; elimination of peaking operations; elimination of whitewater recreation flows; changed bypass release requirements; and any conditions imposed by the Oregon Department of Environmental Quality as part of its water quality certification[4] of J.C. Boyle Dam and its associated facilities. The main changes to Copco No. 2 would be: an increase of minimum flows for the Bypass Reach; installation of upstream and downstream fish passage facilities; and any conditions imposed by the State Water Board as part of its water quality certification of Copco No. 2 and its associated facilities[4]. Flow-related requirements would reduce power generation at J.C. Boyle Dam relative to existing conditions.

This alternative assumes that USBR's flow requirements would be the same as those required under the current federal Endangered Species Act requirements (i.e., 2013 BiOp Flows and 2017 court-ordered flushing and emergency dilution flows) and considers conditions with and without the 2017 court-ordered flushing and emergency dilution flows for potential impacts related to fish disease.

Retaining J.C. Boyle and Copco No. 2 dams would reduce the amount and duration of short-term sediment release and it would reduce construction and waste disposal in California, thus reducing the associated significant impacts compared to the Proposed Project. This alternative would also allow some non-peaking hydropower production to continue – less than under the existing condition or Continued Operation with Fish Passage Alternative, but more than under the Three Dam Removal Alternative. However, while this alternative would further the underlying purpose and related objectives of providing fish passage, fish survival through fishways would be reduced as compared to passage through un-dammed stream reaches. Thus, the Two Dam Removal Alternative would further the underlying purpose and Proposed Project objectives, but not to the same extent as the Proposed Project.

[4] This alternative does not make any assumptions about potential Oregon and California water quality certification conditions.

No Hatchery Alternative

The No Hatchery Alternative is the same as the Proposed Project, except that modification and operation of Fall Creek Hatchery would not occur, and the Iron Gate Hatchery operations would end upon dam removal instead of continuing with reduced production for eight years following removal of the dams, as under the Proposed Project. Under this alternative, all production of salmonids would be discontinued after hatchery releases occur in the fall of dam removal year 1 and the reduced production goals for the Proposed Project would not occur. Construction activities would include all those identified under the Proposed Project, except that: Iron Gate Hatchery facilities would be completely removed; and, Fall Creek Hatchery would not be refurbished and would not reopen. Water diversions to operate the hatcheries would not be needed. This alternative would reduce construction-related impacts associated with the reopening of Fall Creek Hatchery, modifications to provide water, and installation of a new fish ladder at Iron Gate Hatchery.

The No Hatchery Alternative would further the underlying purpose and objectives, although the alternative would not meet Objective 2 (to advance the long-term restoration of the natural fish population in the Klamath Basin, with particular emphasis on restoring the salmonid fisheries used for subsistence, commerce, tribal cultural purposes, and recreation) as quickly as under the Proposed Project.

Public Involvement and Agency Consultation

The State Water Board solicited public and agency input for the Lower Klamath Project and Alternatives, in accordance with CEQA Guidelines Section 15082. The *Notice of Preparation and Scoping Meetings for an Environmental Impact Report for the Lower Klamath Project License Surrender (NOP)* was issued for a 42-day public comment period (December 22, 2016 to February 1, 2017). The State Water Board held three public scoping meetings (in Arcata, Sacramento, and Yreka) in January 2017 to solicit input (see the *Scoping Report* attached as Appendix A). A total of 1,418 oral and written comments were received. Seven comment emails or letters were received after the close of the comment period and were included in the *Scoping Report*.

In addition to the formal scoping process, the State Water Board has consulted with and/or obtained comments from various Native American Tribes, state and federal public agencies, affected local agencies, and stakeholders, including, but not limited to:

- CALFIRE
- California Coastal Commission
- California Department of Fish and Wildlife (CDFW) Region 1 (includes participation in KRRC Technical Workgroup Inter-agency Meetings)
- California Natural Resources Agency
- National Marine Fisheries Service (includes participation in KRRC Technical Workgroup Inter-agency Meetings)
- Native American Tribes – Shasta Nation, Shasta Indian Nation, Yurok Tribe, Karuk and Hoopa Valley Tribes
- Oregon Department of Environmental Quality
- Siskiyou County

- United States Bureau of Reclamation (USBR)
- United States Fish and Wildlife Service (USFWS) (includes participation in KRRC Technical Workgroup Inter-agency Meetings)
- United States Geological Survey

Areas of Controversy

CEQA Guidelines Section 15123 requires disclosure of the controversial project issues known to the Lead Agency, including those raised by agencies and the public. Table ES-2 highlights controversies raised by agencies and the public during the scoping period and other forums. Additional information concerning these areas of controversy and others can be found in the Scoping Report (Appendix A of this EIR). Opinions and issues raised by agencies and members of the public do not necessarily represent the position of the State Water Board.

Table ES-2. Areas of Controversy and Issues Raised by Agencies and the Public.

Topic	Issue Raised and Area of Controversy	EIR Section(s), If Applicable
Geographic Scope of EIR	The geographic scope of the EIR's area of analysis.	Sections 1.1 through 1.4, as well as individual areas of analysis in each Section 3 resource area
Range of Alternatives of EIR	Concern that alternatives besides the Proposed Project be addressed, including a dams-in alternative	Section 4
Fisheries and Aquatic Resources	The potential for the Proposed Project to improve fisheries in the Klamath Basin, and the range of historic fisheries.	Section 3.3.2.1
	Concern that sediment release during dam removal will have significant and deleterious effects on the aquatic environment from Iron Gate Dam to the Pacific Ocean during the period of dam removal.	Sections 3.3.5.1 and Appendix E
	Loss of sucker habitat in reservoirs	Sections 3.3.2.1 and Potential Impact 3.3-13
Water Quality	The short- and long-term water quality impacts associated with the Proposed Project. Water quality related concerns include the amount, toxicity, and fate and transport of sediment behind the dams; duration of short-term impacts; and the consequences of conversion of the system from reservoirs to riverine.	Section 3.2
Water for Agriculture, Fire Suppression, and Environmental Uses	Concern that removal of the Project dams will adversely impact irrigation in the Scott and Shasta river basins.	Section 3.8.2.2
	Reservoirs serve as a water source for fighting regional wildland fires. Potential for reduced water sources for fire suppression efforts with loss of the reservoirs.	Section 3.17.5, Potential Impact 3.17-3 Sections 3.21.5, Potential Impact 3.21-8
	Concern regarding loss of water provided from the reservoirs for additional summer instream flows.	Section 3.3.5.5
	Concern regarding loss of agricultural irrigation supply to farmers in the upper basin areas of California and Oregon.	Section 3.8.2.1 and Section 3.8.5, Potential Impact 3.8-2
	Concern regarding changes in groundwater table and associated water supply with loss of the reservoirs.	Section 3.7.5
Flood Hydrology	Concern regarding changes to flow regulation and flood control.	Section 3.6.2.3 and Section 3.6.5, Potential Impact 3.6-1, 3.6-3, and 3.6-4
Loss of Renewable Power Supply	Concern that loss of the Project will result in the loss of renewable power.	Section 3.10.2, Potential Impacts 3.10-1 and 3.10-2

Topic	Issue Raised and Area of Controversy	EIR Section(s), If Applicable
Regional Economic Impacts	Concern regarding lost power generation and impacts to local real estate.	Section 5.4
	Concern regarding ongoing impacts to commercial fisheries due to negative effects of dams on habitat quantity and quality	Section 5.4
Upper Klamath Basin	Analysis needs to include consideration of the Oregon dams and the Upper Klamath Basin Irrigation Project.	Throughout, particularly Sections 3.2, 3.3, 3.8, and 3.24
Loss of Reservoir Environment	Dam removal would result in a loss of reservoirs, affecting individuals that live on or near the reservoirs and who value the reservoirs' aesthetic and recreational values.	Section 3.19.2 and Section 3.19.5, Potential Impacts 3.19-1, 3.19-4, 3.19-5 Section 3.20.2.3 and Section 3.20.5, Potential Impact 3.20-2
Environmental Law Compliance	Concern that dam removal is premature and/or a pre-determined outcome.	Sections 1.1 through 1.5 and all impact analyses considered in Sections 3 and 4
Changes in Recreational Uses, including Types and Amounts of Whitewater Boating	Peaking flows from operation of the hydroelectric project currently allow for commercial whitewater boating in mid- to late-summer. Concern regarding loss of whitewater boating flows.	Section 3.20.2.2 and Section 3.20.5, Potential Impact 3.20-5
Siskiyou County Advisory Election Vote November 2, 2010 (Measure G).	The Siskiyou County ballot asked, "Should the Klamath River Dams (Iron Gate, Copco 1, and Copco 2) and associated hydroelectric facilities be removed – Yes or No?" 78.84 percent of voters expressing an opinion voted No to dam removal, while 21.86 percent voted Yes.	While this is not an environmental impact the State Water Board acknowledges vote in Section 2.6.1
Traffic and Road Conditions	Concern that there may be construction-related impacts to local traffic and road conditions, and effects on emergency response times.	Section 3.22

Please refer to the Scoping Report (Appendix A of this EIR) for further information on issues identified by agencies and the public during the public scoping process. The Scoping Report can also be found online at: http://www.swrcb.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/scoping_report.pdf. Scoping Report appendices are available separately on the Lower Klamath Project webpage. The State Water Board's Proposed Project webpage has other pertinent descriptions and links to documents and is available online at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/lower_klamath_ferc14803.shtml.

Issues to be Resolved

CEQA Guidelines Section 15123 requires disclosure of issues to be resolved.

It is clear that the Klamath River has significantly degraded water quality and aquatic resources, and that these ongoing impacts stem from multiple factors including operation of the hydroelectric facilities. It is also clear that removal of the Lower Klamath Project dams and associated facilities under the Proposed Project is a large undertaking that would itself involve negative as well as positive environmental consequences, particularly in the short term. The degree of environmental impacts and benefits for the proposed restoration project are issues to be resolved, as is the potential for mitigation of impacts both within and outside of the State Water Board's purview.

Based solely on a comparison to the existing condition (summarized in Table ES-1), the alternative with the least number of unmitigable adverse environmental impacts would be the Continued Operations with Fish Passage Alternative. However, the Proposed Project is a restoration project aimed at improving the aquatic ecosystem in the Klamath River over the long term. Therefore, in identifying the environmentally superior alternative in this context, it makes sense to evaluate the degree of benefit that the alternatives provide above the current degraded condition, as well as the duration and severity of negative impacts. Based on the potential impacts and effects identified in this EIR (summarized in Table ES-1), the Proposed Project would result in significantly more identified benefits for environmental resources than the Continued Operations with Fish Passage Alternative, including all of the benefits listed above under *Effects Found to be Beneficial*. Further, the majority of the unmitigable adverse impacts identified under the Proposed Project would occur in the short term, during reservoir drawdown and construction activities associated with hydroelectric facilities removal. In looking at the range of benefits and impacts the State Water Board has identified the Proposed Project as the environmentally superior alternative.

The KRRC proposes to further develop Proposed Project actions relating to certain state and local regulatory requirements for several resource areas that fall outside of State Water Board's water quality certification authority. The State Water Board anticipates implementation of additional measures (e.g., good neighbor agreements between the KRRC and relevant state or local agencies, recommended measures in this EIR, and any modifications developed through the FERC process that provide the same or better level of protection for the resource in question) would reduce impacts. The EIR notes where such protection would eliminate the potential for a significant impact. However, the State Water Board cannot ensure implementation of good neighbor agreements, recommended measures included in this EIR, or modifications anticipated to be developed through the FERC process. Therefore, the State Water Board has identified impacts that rely on implementation of such agreements or recommended measures in this EIR as significant and unavoidable.

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USFWS and NMFS (National Marine Fisheries Service). 2007. United States Department of the Interior and National Marine Fisheries Service modified prescriptions for fishways and alternatives analysis pursuant to Section 18 and Section 33 of the Federal Power Act for the Klamath Hydroelectric Project (FERC Project No. 2082).

Table ES-1. Summary of Impacts and Mitigation Measures.

Potential Impacts **PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative**								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Water Quality								
Potential Impact 3.2-1. Short-term and long-term alterations in water temperatures due to conversion of the reservoir areas to a free-flowing river.								
Hydroelectric Reach to the confluence with the Salmon River	S	L	PP, PR, 2R, 3R, NH					
Middle Klamath River downstream from the Salmon River, Lower Klamath River, Klamath River Estuary, Pacific Ocean nearshore environment	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.2-2. Short-term and long-term alterations in seasonal water temperatures in the Klamath River Estuary due to morphological changes induced by dam removal sediment release and subsequent deposition in the estuary.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.2-3. Increases in suspended sediments due to release of sediments currently trapped behind the dams.								
	S			NP, CO			PP, PR, 2R, 3R, NH	
		L		PP, PR, CO, 2R, 3R, NH				
Potential Impact 3.2-4. Increases in suspended material from stormwater runoff due to pre-construction, dam deconstruction and removal, and restoration activities in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam.								
	S				WQ-1, TER-1, HZ-1	PP, PR, 2R, 3R, NH		
Potential Impact 3.2-5. Long-term alterations in mineral (inorganic) suspended material from the lack of continued interception and retention by the dams.								
		L		PP, PR, 2R, 3R, NH				

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.2-6. Long-term alterations in algal-derived (organic) suspended material from the lack of continued interception and retention by the dams.								
		L		PP, PR, 2R, 3R, NH				
Potential Impact 3.2-7. Short-term increases in sediment-associated nutrients due to release of sediments currently trapped behind the dams.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.2-8. Long-term alterations in nutrients from the lack of interception and retention by the dams and conversion of the reservoir areas to a free-flowing river.								
Annual interception and retention of total nutrients		L		PP, PR, 2R, 3R, NH				
Potential seasonal release of dissolved nutrients		L	PP, PR, 2R, 3R, NH					
Potential Impact 3.2-9. Short-term increases in oxygen demand and reductions in dissolved oxygen due to release of sediments currently trapped behind the dams.								
Hydroelectric Reach and Middle Klamath River from Iron Gate Dam to the Salmon River	S			NP, CO			PP, PR, 2R, 3R, NH	
Middle Klamath River downstream from the Salmon River, Lower Klamath River, Klamath River Estuary	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.2-10. Long-term alterations in dissolved oxygen concentrations and daily variability due to conversion of the reservoir areas to a free-flowing river.								
Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam (daily fluctuations)		L		PP, PR, 2R, 3R, NH				
Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam (elimination of summer and fall extremes)		L	PP, PR, 2R, 3R, NH					
Hydroelectric Reach and Middle Klamath River (winter and spring)		L		PP, PR, 2R, 3R, NH				
Lower Klamath River, Klamath River Estuary, and Pacific Ocean nearshore environment		L		PP, PR, 2R, 3R, NH				

Potential Impacts **PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative**								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.2-11. Alterations in pH and daily pH fluctuations due to a conversion of the reservoir areas to a free-flowing river.								
Hydroelectric Reach at Oregon-California state line	S	L		PP, PR, 2R, 3R, NH				
Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam	S	L	PP, PR, 2R, 3R, NH					
Middle Klamath River, Klamath River Estuary, Pacific Ocean nearshore environment	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.2-12. Alterations in chlorophyll-a and algal toxins due to a conversion of the reservoir areas to a free-flowing river.								
	S	L	PP, PR, 2R, 3R, NH					
Potential Impact 3.2-13. Human exposure to inorganic and organic contaminants due to release and exposure of reservoir sediment deposits.								
	S	L			WQ-2, WQ-3	PP, PR, 2R, 3R, NH		
Potential Impact 3.2-14. Freshwater aquatic species exposure to inorganic and organic contaminants due to release of sediments currently trapped behind the dams.								
	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.2-15. Short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration activities in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam.								
	S				WQ-1, TER-1, HZ-1	PP, PR, 2R, 3R, NH		
Potential Impact 3.2-16. Short-term impacts to aquatic biota from herbicide application during restoration of the reservoir areas.								
	S				WQ-4	PP, PR, 2R, 3R, NH		

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.2-17. Short-term and long-term influence of changes in Iron Gate and Fall Creek hatchery production on Klamath River and Fall Creek water quality.								
Water quality in the Middle Klamath River downstream of Iron Gate Hatchery	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Water temperature and dissolved oxygen in Fall Creek downstream of Fall Creek Hatchery	S			NP, CO, NH			PP, PR, 2R, 3R	
Water quality (except water temperature and dissolved oxygen) in Fall Creek downstream of Fall Creek Hatchery		L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.2-18. Short-term impacts on water quality from construction activities on Parcel B lands.								
	S	L			WQ-1, TER-1, HZ-1	PP, PR		
Potential Impact 4.2.2-1 Seasonal alterations in water temperature due to continued impoundment of water in the reservoirs.								
J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir	S	L	CO	NP (S only)				
Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam and the Middle Klamath River to the confluence with the Salmon River	S	L		NP (S only), CO				
Middle Klamath River downstream of the confluence with the Salmon River, the Lower Klamath River, and the Klamath River Estuary, and the Pacific Ocean nearshore environment	S	L		NP (S only), CO				
Potential Impact 4.2.2-2. Seasonal increases in algal-derived (organic) suspended material due to continued impoundment of water in the reservoirs.								
Hydroelectric Reach from J.C. Boyle Reservoir to the upstream end of Copco No. 1 Reservoir	S	L		NP (S only), CO				
Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, the Middle and Lower Klamath River, and the Klamath River Estuary	S	L		NP (S only), CO				

Potential Impacts **PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative**									
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 4.2.2-3 Increases in suspended material due to implementation of 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam.									
	S	L		NP (S only), CO				
Potential Impact 4.4.2-1. Short-term increases in suspended material and contaminants from stormwater runoff due to construction activities associated with replacement and construction of new fish passage facilities.									
Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam	S			CO	WQ-1, TER-1, HZ-1			
Potential Impact 4.2.2-4. Annual interception and retention of nutrients and seasonal release of nutrients due to continued impoundment of water in the reservoirs.									
Hydroelectric Reach and Middle Klamath River (annual interception and retention of nutrients)	S	L		NP (S only), CO				
Hydroelectric Reach and the Middle Klamath River (seasonal release of nutrients)	S	L		NP (S only), CO				
Potential Impact 4.2.2-5. Seasonal low dissolved oxygen concentrations due to continued impoundment of water in the reservoirs.									
Hydroelectric Reach and the Middle Klamath River	S	L		NP (S only), CO				
Middle Klamath River downstream of Seiad Valley, the Lower Klamath River, and the Klamath River Estuary	S	L		NP (S only), CO				
Potential Impact 4.2.2-6. Seasonal high pH and daily pH fluctuations due to continued impoundment of water in the reservoirs.									
Hydroelectric Reach and the Middle Klamath River	S	L		NP (S only), CO				
Middle Klamath River downstream of Seiad Valley the Lower Klamath River, and the Klamath River Estuary	S	L		NP (S only), CO				
Potential Impact 4.2.2-7. Seasonal increases in chlorophyll-*a* and algal toxins due to continued impoundment of water in the reservoirs.									
Hydroelectric Reach from J.C. Boyle Reservoir to upstream end of Copco No. 1 Reservoir	S	L		NP (S only), CO				
Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, the Middle and Lower Klamath River, and the Klamath River Estuary	S	L		NP (S only), CO				

Potential Impacts
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Geographic or Other Additional Information (as needed)	Time Frame[1]		Beneficial	No Significant Impact[2]	Mitigation	No Significant Impact with Mitigation	Significant and Unavoidable	Significant and Unavoidable with Mitigation
Potential Impact 4.2.2-8. Human and freshwater aquatic species' exposure to inorganic and organic contaminants due to continued impoundment of water in the reservoirs.								
	S	L		NP (S only), CO				
Aquatic Resources								
Potential Impact 3.3-1. Effects on coho salmon critical habitat quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.								
	S				AQR-1 and AQR-2	PP, PR, 2R, 3R, NH		
		L	PP, PR, 2R, 3R, NH					
Potential Impact 3.3-2. Effects on southern resident killer whale critical habitat quality due to short-term and long-term alterations to salmon populations due to dam removal.								
	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.3-3. Effects on eulachon critical habitat quality due to short-term sediment releases due to dam removal.								
	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.3-4. Effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.								
	S				AQR-1 and AQR-2	PP, PR, 2R, 3R, NH		
		L	PP, PR, 2R, 3R, NH					
Potential Impact 3.3-5. Effects on groundfish Essential Fish Habitat (EFH) quality due to short-term sediment releases and long-term changes in habitat quality due to dam removal.								
	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.3-6. Effects on pelagic fish Essential Fish Habitat (EFH) quality due to short-term sediment releases and long-term changes in habitat quality due to dam removal.								
	S	L		PP, PR, 2R, 3R, NH				

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative									
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.3-7. Effects on the fall-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.									
	S			PP, PR, 2R, 3R, NH				
		L	PP, PR, 2R, 3R, NH					
Potential Impact 3.3-8 Effects on the spring-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.									
	S			PP, PR, 2R, 3R, NH				
		L	PP, PR, 2R, 3R, NH					
Potential Impact 3.3-9. Effects on coho salmon populations due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.									
	S			PP, PR, 2R, 3R, NH				
		L	PP, PR, 2R, 3R, NH					
Potential Impact 3.3-10. Effects on the steelhead population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.									
	S			PP, PR, 2R, 3R, NH				
		L	PP, PR, 2R, 3R, NH					

Potential Impacts
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Geographic or Other Additional Information (as needed)	Time Frame[1]		Beneficial	No Significant Impact[2]	Mitigation	No Significant Impact with Mitigation	Significant and Unavoidable	Significant and Unavoidable with Mitigation
Potential Impact 3.3-11. Effects on the Pacific lamprey population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.								
	S			PP, PR, 2R, 3R, NH				
		L	PP, PR, 2R, 3R, NH					
Potential Impact 3.3-12. Effects on the green sturgeon population due to short-term sediment releases and long-term changes in habitat quality due to dam removal.								
	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.3-13. Effects on Lost River and shortnose sucker populations due to short- and long-term changes in habitat quality and quantity due to dam removal.								
	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.3-14. Effects on the redband trout population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.								
	S			PP, PR, 2R, 3R, NH				
		L	PP, PR, 2R, 3R, NH					
Potential Impact 3.3-15. Effects on the eulachon population due to short-term sediment releases and long-term changes in habitat quality due to dam removal.								
	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.3-16. Effects on the longfin smelt population due to short-term sediment releases and long-term changes in habitat quality due to dam removal.								
	S	L		PP, PR, 2R, 3R, NH				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.3-17. Effects on species interactions between introduced resident fish species and native aquatic species due to short- and long-term changes in habitat quality and quantity due to dam removal.								
	S	L	PP, PR, 2R, 3R, NH					
Potential Impact 3.3-18. Effects on aquatic species from interactions among fish species due to short- and long-term changes in habitat quantity due to dam removal.								
	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.3-19. Effects on freshwater mollusks populations due to short-term sediment releases and long-term changes in habitat quality due to dam removal.								
M. falcata, *G. angulata*, and freshwater clams	S	L		PP, PR, 2R, 3R, NH				
Anodonta spp.	S	L		2R, 3R			PP, PR, NH	
Potential Impact 3.3-20. Effects on fish species from alterations to benthic macroinvertebrates due to short-term sediment releases and long-term changes in habitat quality due to dam removal.								
	S			PP, PR, 2R, 3R, NH				
		L	PP, PR, 2R, 3R, NH					
Potential Impact 3.3-21. Effects on aquatic resources due to short-term noise disturbance and water quality alterations from construction and deconstruction activities.								
	S	L		PP, PR, 2R, 3R, NH				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.3-22. Effects on aquatic species due to short-term noise disturbance and water quality alterations from deconstruction activities and long-term fish screen upgrades from the relocation of the City of Yreka Water Supply Pipeline.								
	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.3-23. Effects on anadromous salmonid populations due to short-term and long-term Bogus Creek flow diversions for the Iron Gate Hatchery.								
	S			NP, CO, NH	AQR-3	PP, PR, 2R, 3R		
		L			AQR-3	PP, PR, 2R, 3R		
Potential Impact 3.3-24. Effects on anadromous salmonid populations due to short-term and long-term Fall Creek flow diversions for the Fall Creek Hatchery.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R. NH				
Potential Impact 4.2.3-1 Effects on coho salmon critical habitat quality and quantity due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-2 Effects on southern resident killer whale critical habitat quality due to alterations to salmon populations due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 4.2.3-3. Effects on eulachon critical habitat quality due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-4. Effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-5. Effects on groundfish Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-6. Effects on pelagic fish Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-7. Effects on the fall-run Chinook salmon population due to continued operations of the Lower Klamath Project.								
	S			NP, CO				
		L	CO					
Potential Impact 4.2.3-8. Effects on the spring-run Chinook salmon population due to continued operations of the Lower Klamath Project.								
	S			NP, CO				
		L	CO					
Potential Impact 4.2.3-9. Effects on coho salmon populations due to continued operations of the Lower Klamath Project.								
	S			NP, CO				
		L	CO					

Potential Impacts
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2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative

Geographic or Other Additional Information (as needed)	Time Frame[1]		Beneficial	No Significant Impact[2]	Mitigation	No Significant Impact with Mitigation	Significant and Unavoidable	Significant and Unavoidable with Mitigation
Potential Impact 4.2.3-10. Effects on the steelhead population due to continued operations of the Lower Klamath Project.								
	S			NP, CO				
		L	CO					
Potential Impact 4.2.3-11. Effects on the Pacific lamprey population due to continued operations of the Lower Klamath Project.								
	S			NP, CO				
		L	CO					
Potential Impact 4.2.3-12. Effects on the green sturgeon population due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-13. Effects on Lost River and shortnose sucker populations due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-14. Effects on the redband trout population due to continued operations of the Lower Klamath Project.								
	S			NP, CO				
		L	CO					
Potential Impact 4.2.3-15. Effects on the eulachon population due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-16. Effects on the longfin smelt population due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative									
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 4.2.3-17. Effects on species interactions between introduced resident fish species and native aquatic species due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-18. Effects on aquatic species from interactions among fish species due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-19. Effects on freshwater mollusks populations due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-20. Effects on fish species from alterations to benthic macroinvertebrates due to continued operations of the Lower Klamath Project.								
	S	L		NP (S only), CO				
Potential Impact 4.2.3-21. Alterations to aquatic habitat from implementation of California Klamath Restoration Fund/Coho Enhancement (IM2).								
Coho salmon, fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, freshwater mussels, and benthic macroinvertebrates	S	L	NP (S only), CO					
Redband trout, shortnose and Lost River suckers, green sturgeon, eulachon, and southern resident killer whales	S	L		NP (S only), CO				
Potential Impact 4.4.3-1 Effects on aquatic resources due to short-term noise disturbance and water quality alterations from fishway construction activities.								
	S				WQ-1, HZ-1	CO		

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Geographic or Other Additional Information (as needed)	Time Frame[1]		Beneficial	No Significant Impact[2]	Mitigation	No Significant Impact with Mitigation	Significant and Unavoidable	Significant and Unavoidable with Mitigation
Phytoplankton and Periphyton								
Potential Impact 3.4-1 Short-term increase in growth of nuisance and/or noxious phytoplankton blooms due to increases in sediment-associated nutrients from release of sediments currently trapped behind the Lower Klamath Project dams.								
	S			PP, NP, PR, CO 2R, 3R, NH				
Potential Impact 3.4-2 Alterations in the spatial extent, temporal duration, transport, or concentration of nuisance and/or noxious phytoplankton blooms and concentrations of algal toxins due to dam removal and elimination of reservoir habitat.								
Hydroelectric Reach through the Klamath River Estuary	S	L	PP, PR, 2R, 3R, NH					
Pacific Ocean nearshore environment	S	L		PP, PR, 2R, 3R, NH				
Potential Impact 3.4-3. Short-term increase in growth of nuisance periphyton species due to increases in sediment-associated nutrients from release of sediments currently trapped behind the Lower Klamath Project dams.								
	S			PP, NP, PR, CO 2R, 3R, NH				
Potential Impact 3.4-4. Alterations in the growth of nuisance periphyton species in the Hydroelectric Reach due to increased nutrients and available low-gradient channel margin habitat formed by conversion of the reservoir areas to a free-flowing river and the elimination of hydropower peaking operations.								
Hydroelectric Reach from the Oregon-California state line to Copco No. 1 Reservoir	S	L					PP, PR, 2R, 3R, NH	
Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam	S	L		PP, PR, 2R, 3R, NH				

Potential Impacts **PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative**								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.4-5. Alterations in biomass of nuisance periphyton species due to increased nutrients from upstream dam removal and conversion of the reservoir areas to a free-flowing river.								
Middle and Lower Klamath River and the Klamath River Estuary		L		PP, PR, 2R, 3R, NH				
Potential Impact 4.2.4-1 Variations in nuisance periphyton species abundance downstream of Iron Gate Dam due to implementation of 2017 court-ordered flushing and emergency dilution flows.								
Middle Klamath River from Iron Gate Dam to the Shasta River	S		NP					
Middle Klamath River downstream of the confluence with the Salmon River and the Lower Klamath River	S			NP				
Potential Impact 4.4.4-1 Long-term occurrence of nuisance and/or noxious phytoplankton blooms in the reservoirs.								
Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary		L		CO				
Potential Impact 4.4.4-2 Long-term colonization of nuisance periphyton in riverine reaches.								
Hydroelectric Reach		L		CO				
Middle Klamath River from Iron Gate Dam to the Shasta River		L	CO					
Middle Klamath River downstream of the confluence with the Salmon River and the Lower Klamath River		L		CO				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Terrestrial Resources								
Potential Impact 3.5-1 Construction-related impacts on wetland and riparian vegetation communities.								
	S			NP	TER-1	PP, PR, 2R, 3R, NH		
	S				TER-1 and TER-5	CO		
Potential Impact 3.5-2 Short-term and long-term impacts on wetland and riparian vegetation communities along existing reservoir shorelines due to reservoir drawdown.								
	S	L		PP, NP (S only) PR, CO, 2R, 3R NH				
Potential Impact 3.5-3. Short-term and long-term impacts on wetland habitat downstream of the Lower Klamath Project dams due to erosion or sediment deposition.								
	S	L		PP, NP (S only) PR, CO, 2R, 3R NH				
Potential Impact 3.5-4. Effects on riparian habitat downstream of the Lower Klamath Project dams due to short-term and long-term erosion or sediment deposition.								
	S			PP, PR, 2R, 3R, NP, CO, NH				
		L	PP, PR, 2R, 3R, NH	CO				
Potential Impact 3.5-5. Short-term and long-term impacts on native vegetation due to increased invasive plant species establishment.								
	S	L		NP (S only)		PP, PR, 2R, 3R, NH		

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.5-6. Short-term and long-term impacts on culturally significant species in riparian and wetland habitats.								
	S			NP	TER-1	PP, PR, 2R, 3R, NH, CO		
		L		PP, PR, 2R, 3R, NH, CO				
Potential Impact 3.5-7. Short-term impacts on special-status plants and rare natural communities from construction-related activities. *								
Rare natural communities	S			PP, NP, PR, CO, 2R, 3R, NH				
Special-status	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.5-8. Short-term and long-term impacts on special-status plants from reservoir removal. *								
	S	L		NP (S only), CO			PP, PR, 2R, 3R, NH	
Potential Impact 3.5-9. Short-term impacts on special-status terrestrial invertebrates from construction-related activities.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.5-10. Short-term impacts on special-status amphibian, reptiles, and mammals from construction activities. *								
Amphibians and reptiles	S			NP	TER-2 and TER-3	PP, PR, CO, 2R, 3R, NH		
Mammals	S			NP			PP, PR, CO, 2R, 3R, NH	

Potential Impacts
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Geographic or Other Additional Information (as needed)	Time Frame[1]		Beneficial	No Significant Impact[2]	Mitigation	No Significant Impact with Mitigation	Significant and Unavoidable	Significant and Unavoidable with Mitigation
Potential Impact 3.5-11. Short-term impacts on nesting birds from construction-related noise and habitat alterations. *								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.5-12. Effects on willow flycatcher from short-term construction-related noise and short-term and long-term habitat alterations. *								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Riparian habitat in the former location of Copco No. 1 and Iron Gate reservoirs		L	PP, PR, 2R, 3R, NH	CO				
Potential Impact 3.5-13. Short-term impacts on bald and golden eagles from construction-related noise and habitat alterations. *								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.5-14. Short-term and long-term impacts on bats from construction noise and loss of roosting habitat. *								
	S	L		NP (S only)			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.5-15. Short-term and long-term impacts on northern spotted owl and critical habitat from construction-related noise and habitat alterations.								
	S	L		PP, NP (S only) PR, CO, 2R, 3R, NH				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.5-16. Effects on special-status amphibians and reptiles in riverine habitats from short-term high suspended sediment concentrations and flows and long-term changes in water quality.								
Pacific tailed frog, southern torrent salamander, northern red-legged frog, and western pond turtle	S			PP, NP, PR, CO, 2R, 3R, NH				
Foothill yellow-legged frog egg masses, if present	S			CO, NP			PP, PR, 2R, 3R, NH	
All special-status amphibians and reptiles		L	PP, PR, 2R, 3R, NH	CO				
Potential Impact 3.5-17. Effects on benthic macroinvertebrates from short-term dewatering and sedimentation and long-term alterations to habitat.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
		L	PP, PR, 2R, 3R, NH	CO				
Potential Impact 3.5-18. Short-term impacts on amphibian and reptile in riverine habitats from sedimentation.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.5-19. Impacts on native amphibians from loss of reservoir habitat.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.5-20. Short-term and long-term impacts on western pond turtle and amphibians from reduced BMI populations.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.5-21. Short-term and long-term impacts on birds and bats from loss of aquatic reservoir and shoreline vegetative habitat.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.5-22. Short-term and long-term impacts on western pond turtle from loss of aquatic habitat.								
	S	L		NP (S only), CO	TER-4	PP, PR, 2R, 3R, NH		
Potential Impact 3.5-23. Long-term effects on deer from alterations to winter range habitat.								
		L	PP, PR, 2R, 3R, NH	CO				
Potential Impact 3.5-24. Effects on terrestrial species from herbicide use during reservoir restoration activities.								
Special-status plants and wildlife	S			PP, NP, PR, CO, 2R, 3R, NH				
Rare natural communities, wetlands, and riparian vegetation		L	PP, PR, 2R, 3R, NH	CO				
Potential Impact 3.5-25. Effects on wildlife from increased habitat for salmonids and changes in hatchery production.								
	S	L	PP, PR, 2R, 3R, NH	NP (S only), NH, CO				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.5-26. Impacts on special-status wildlife from Bogus Creek flow diversions.								
	S			NP, NH, CO	AQR-3	PP, PR, 2R, 3R		
Potential Impact 3.5-27. Impacts on special-status wildlife from Fall Creek flow diversions.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.5-28. Impacts on sensitive habitats and special-status terrestrial wildlife and plant species from construction activities on Parcel B lands. *								
		L			WQ-1, TER-1, and TER-4			PP, PR, 2R, 3R, NH, CO
Potential Impact 3.5-29. Long-term effects on wildlife from alteration of wildlife movement corridors.								
Increased wildlife movement opportunities		L	PP, PR, 2R, 3R, NH	CO				
Wildlife-friendly fencing		L		PP, PR, 2R, 3R, NH				
Potential Impact 3.5-30. Long-term effect on terrestrial wildlife from an increase in the distribution of salmon-derived nutrients upstream of Iron Gate, Copco No. 1 and Copco No. 2 dams.								
		L	PP, PR, NH, CO	2R, 3R				
Potential Impact 4.2.5-1. Effects of 2017 court-ordered flushing and emergency dilution flows released from Iron Gate Dam on foothill yellow-legged frog and western pond turtle breeding.								
Hydroelectric Reach (foothill yellow-legged frogs)	S						NP, CO	
Hydroelectric Reach (western pond turtles)	S			NP, CO				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Flood Hydrology								
Potential Impact 3.6-1 Reservoir drawdown and dam removal could result in short-term increases in downstream surface water flows and result in exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.6-2 Under the Proposed Project recreational facilities currently located on the banks of the existing reservoirs would be removed following drawdown and could change flood hydrology.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.6-3. The long-term FEMA100-year floodplain inundation extent downstream from Iron Gate Dam could change between river miles 193 and 174, potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.								
Exposing structures to a substantial risk of damage due to flooding		L					PP, PR, 2R, 3R, NH	
Exposing people and/or structures to a substantial risk of flooding related to flood forecasting		L		PP, PR, 2R, 3R, NH				
Potential Impact 3.6-4. The FEMA 100-year floodplain inundation extent downstream from J.C. Boyle Dam could change between the California-Oregon state line and Copco No. 1 Reservoir, potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.								
		L		PP, PR, 2R, 3R, NH				

Geographic or Other Additional Information (as needed)	Time Frame[1]		Beneficial	No Significant Impact[2]	Mitigation	No Significant Impact with Mitigation	Significant and Unavoidable	Significant and Unavoidable with Mitigation
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Potential Impact 3.6-5. The release of sediment stored behind the Lower Klamath Project dams and resulting downstream sediment deposition under the Proposed Project could result in potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.6-6. Dam failure could flood areas downstream of the Lower Klamath Project.								
	S			PP, NP, PR, 2R, 3R, NH, CO				
		L	PP, PR, 2R, 3R, NH	CO				
Potential Impact 4.2.6-1. The FEMA 100-year floodplain inundation extent downstream from Iron Gate Dam could change due to 2017 flow requirements, potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.								
	S	L		NP (S only), CO				
Potential Impact 4.2.6-2. The FEMA 100-year floodplain inundation extent downstream from J.C. Boyle Dam could change due to 2017 flow requirements between the California-Oregon state line and Copco No. 1 Reservoir, potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.								
	S	L		NP (S only), CO				
Groundwater Resources								
Potential Impact 3.7-1. Groundwater levels in existing wells adjacent to the reservoirs could decline in response to the decrease in reservoir surface-water elevations if the dams, and therefore reservoirs, are removed.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.7-2. The Proposed Project could interfere with groundwater recharge and adversely affect surface water conditions in the Klamath River.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				

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Water Supply/Water Rights								
Potential Impact 3.8-1 Dam removal could change the amount of surface water flow available for diversion under existing water rights in the mainstem Klamath River within the Hydroelectric Reach and downstream from Iron Gate Dam.								
	S	L		PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.8-2. Dam removal could change the amount of surface water flow available for diversion from Upper Klamath Lake and/or Keno Reservoir to California water users in the USBR Klamath Irrigation Project.								
	S	L		PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.8-3. Release of stored sediment during reservoir drawdown could change Klamath River geomorphology and affect water intake pumps downstream from Iron Gate Dam.								
	S			NP, CO	WSWR-1	PP, PR, 2R, 3R, NH		
Potential Impact 3.8-4. Relocation of the City of Yreka water supply pipeline after drawdown of Iron Gate Reservoir could affect water supply.								
	S			NP, CO	WSWR-2	PP, PR, 2R, 3R, NH		
Potential Impact 3.8-5. Removal and potential replacement of recreational facilities currently located on the banks of the existing reservoirs could affect water supply and/or water rights.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 4.2.8-1. Water availability changes from coordinated operations under 2017 flow requirements.								
	S	L		NP (S only), CO				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Air Quality								
Potential Impact 3.9-1. Conflict with or obstruct implementation of the California Regional Haze Plan.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.9-2. Exceedance of the Siskiyou County Air Pollution Control District emissions thresholds in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants).								
	S			NP, CO			PP, PR, 2R, 3R, NH	
Potential Impact 3.9-3. Short-term cumulative increase in criteria pollutants for which the Siskiyou County Air Pollution Control District is non-attainment.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.9-4. Short-term exposure of sensitive receptors to substantial toxic air contaminant concentrations.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.9-5. Short-term exposure to objectionable odors near construction sites.								
	S			PP, NP, PR, CO, 2R, 3R, NH				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Greenhouse Gas Emissions								
Potential Impact 3.10-1. Generation of greenhouse gas emissions, either directly or indirectly, that would exceed 10,000 MT CO2e.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.10-2. Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing GHG emissions.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Geology, Soils, and Mineral Resources								
Potential Impact 3.11-1. Reservoir drawdown could result in changes to geologic hazards, such as seismic or volcanic activity.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.11-2. Soil disturbance associated with heavy vehicle use, excavation, and grading.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.11-3. Reservoir drawdown could result in hillslope instability in reservoir rim areas.								
J.C. Boyle Reservoir	S			PP, NP, PR, CO, NH				
Copco No. 1 Reservoir	S			NP, CO	GEO-1	PP, PR, 2R, 3R, NH		
Iron Gate Reservoir	S			PP, NP, PR, CO, 2R, 3R, NH				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.11-4. Reservoir drawdown could result in short-term instability of embankments at the earthen dams (Iron Gate and J.C. Boyle).								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.11-5. Reservoir drawdown could result in substantial short-term sediment deposition in the Klamath River downstream of Iron Gate Dam due to erosion of reservoir sediment deposits and a long-term change in sediment supply and transport due to dam removal.								
Middle Klamath River to confluence with Cottonwood Creek	S			NP, CO			PP, PR, 2R, 3R, NH	
Middle Klamath River downstream of Cottonwood Creek, Lower Klamath River, Klamath River Estuary, Pacific Ocean nearshore environment	S			PP, NP, PR, CO, 2R, 3R, NH				
Hydroelectric Reach, Middle and Lower Klamath River, Klamath River Estuary		L	PP, PR, 2R, 3R, NH	CO				
Pacific Ocean nearshore environment		L		PP, PR, CO, 2R, 3R, NH				
Potential Impact 3.11-6. Reservoir drawdown could result in increased bank erosion in the Klamath River downstream of Iron Gate Dam.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.11-7. Reservoir drawdown could reduce or eliminate the availability of a known mineral resource or a locally-important mineral resource recovery site.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				

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Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Historical Resources and Tribal Cultural Resources								
Potential Impact 3.12-1. Pre-dam-removal activities that involve disturbance of the landscape, including construction or improvement of associated roads, bridges, water supply lines, staging areas, disposal sites, hatchery modifications, recreation site removal and/or development, and culvert construction and improvements could result in potential exposure of or damage to known Tribal Cultural Resources through ground-disturbing construction and disposal activity and increased access to sensitive areas								
	S	L		NP (S only)	TCR-1, TCR-2, TCR-3, TCR-4			PP, PR, CO, 2R, 3R, NH
Potential Impact 3.12-2. Drawdown of Iron Gate, Copco No. 1, and Copco No. 2 reservoirs could result in shifting, erosion, and exposure of known or unknown, previously submerged Tribal Cultural Resources								
	S	L		NP (S only), CO	TCR-1, TCR-2, TCR-3, TCR-4			PP, PR, 2R, 3R, NH
Potential Impact 3.12-3. Reservoir drawdown could result in erosion or flood disturbance to Tribal Cultural Resources located along the Klamath River								
Hydroelectric Reach between J.C. Boyle Dam and Copco No. 1 Reservoir	S	L		PP, NP, PR, CO, 2R, 3R, NH				
Middle Klamath River from Iron Gate Dam to Humbug Creek	S	L		NP, CO	TCR-1, TCR-2, TCR-3			PP, PR, 2R, 3R, NH
Middle Klamath River downstream of Humbug Creek and Lower Klamath River excluding the Yurok Reservation (approximately RM 0 to RM 45)	S	L		PP, NP, PR, CO, 2R, 3R, NH				
Yurok Reservation (approximately RM 0 to RM 45) along Lower Klamath River and Klamath River Estuary	S	L		NP, CO	TCR-5	PP, PR, 2R, 3R, NH		

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Potential Impact 3.12-4. Project activities associated with removal of Iron Gate, Copco No. 1, and Copco No. 2 dams could result in physical disturbance to known or unknown Tribal Cultural Resources from blasting or other removal techniques								
	S	L		NP (S only)	TCR-1, TCR-2, TCR-3, TCR-4			PP, PR, CO, 2R, 3R, NH
Potential Impact 3.12-5. Ground disturbance associated with reservoir restoration, recreation site removal and/or development, and disposal site restoration could physically disturb known Tribal Cultural Resources. Additionally, ongoing road and recreation site maintenance has the potential to disturb known Tribal Cultural Resources								
	S	L		NP (S only)	TCR-1, TCR-2, TCR-3, TCR-4			PP, PR, CO, 2R, 3R, NH
Potential Impact 3.12-6. During and following reservoir drawdown activities at Iron Gate, Copco No. 1, and Copco No. 2 reservoirs there is an increased potential for looting of Tribal Cultural Resources (short term and long term).								
Iron Gate Reservoir and Copco No. 1 Reservoir	S	L		NP, CO	TCR-2, TCR-4			PP, PR, 2R, 3R, NH
Copco No. 2 Reach	S	L		NP, CO	TCR-2, TCR-4			PP, PR, 3R, NH
Potential Impact 3.12-7. Short-term erosion caused by high-intensity and/or duration precipitation events could cause exposure of or disturbance to known or unknown Tribal Cultural Resources within the reservoir footprints immediately following reservoir drawdown and prior to vegetation establishment/full stabilization of sediment deposits								
	S			NP, CO	TCR-1, TCR-2, and TCR-3		PP, PR, 2R, 3R, NH	
Potential Impact 3.12-8. Long-term (post-removal) impacts to Tribal Cultural Resources as a result of dam removal from increased looting opportunities and from surface and subsurface erosion of Tribal Cultural Resources								
Prior to land transfer		L		CO			PP, PR, 2R, 3R, NH	
After land transfer		L			TCR-1, TCR-2, TCR-3, TCR-6, TCR-7, and TCR-8	PP, PR, 2R, 3R, NH		

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Potential Impact 3.12-9. Klamath Cultural Riverscape Contributing Aspect – Combined effects on the Klamath River fishery of dam removal, changes in hatchery production, and increased habitat for salmonids								
	S			PP, NP, PR, CO, 2R, 3R, NH				
		L	PP, PR, 2R, 3R, NH	CO				
Potential Impact 3.12-10. Klamath Cultural Riverscape Contributing Aspect: Ability of tribes to use the Middle and Lower Klamath River for ceremonial and other purposes due to alterations in riverine water quality and changes in the extent of nuisance and/or noxious blue-green algae blooms.								
	S	L	PP, PR, 2R, 3R, NH	NP (S only), CO				
Potential Impact 3.12-11. Potential impacts to Copco No. 1 Dam, Copco No. 2 Dam, and Iron Gate Dam, their associated hydroelectric facilities, and the Klamath River Hydroelectric Project District as a whole.								
J.C. Boyle Reservoir and associated hydroelectric facilities	S	L		NP (S only), CO			PP, PR, NH	
Copco No. 1 Dam and associated hydroelectric facilities	S	L		NP (S only), CO			PP, PR, 2R, 3R, NH	
Copco No. 2 Dam and associated hydroelectric facilities	S	L		NP (S only), CO			PP, PR, 3R, NH	
Iron Gate Dam and associated hydroelectric facilities	S	L		NP (S only), CO			PP, PR, 2R, 3R, NH	
Klamath River Hydroelectric Project District	S	L		NP (S only), CO			PP, PR, 2R, 3R, NH	

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.12-12 Potential impacts to submerged historic-period archaeological sites upon reservoir drawdown and exposure providing new access opportunities for artifact collecting and unauthorized excavation								
	S	L		NP (S only), CO	TCR-2 and TCR-3			PP, PR, 2R, 3R, NH
Potential Impact 3.12-13. Drawdown of Iron Gate, Copco No. 1, and Copco No. 2 reservoirs could shift, erode, or expose historic-period archaeological resources resulting in increased potential for damage and looting								
	S	L		NP (S only), CO	TCR-2 and TCR-3			PP, PR, 2R, 3R, NH
Potential Impact 3.12-14. Reservoir drawdown could result in short-term erosion or flood disturbance to historic-period cultural resources located along the Klamath River								
Middle Klamath River from Iron Gate Dam to Humbug Creek	S			NP, CO	TCR-3			PP, PR, 2R, 3R, NH
Hydroelectric Reach excluding Iron Gate Dam, Middle Klamath River downstream of Humbug Creek, Lower Klamath River, Klamath River Estuary	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.12-15. Project activities associated with removal of Iron Gate, Copco No. 1, and Copco No. 2 dams could result in physical disturbance to historic-period cultural resources from blasting or other removal techniques								
	S			NP	TCR-3			PP, PR, CO, 2R, 3R, NH
Potential Impact 3.12-16. Ground disturbance associated with reservoir restoration, recreation site removal and/or development, and disposal site restoration could physically disturb historic-period cultural resources. Additionally, ongoing road and recreation site maintenance may have the potential to disturb known historic-period cultural resources								
	S			NP	TCR-2 and TCR-3			PP, PR, CO, 2R, 3R, NH

Geographic or Other Additional Information (as needed)	Time Frame[1]		Beneficial	No Significant Impact[2]	Mitigation	No Significant Impact with Mitigation	Significant and Unavoidable	Significant and Unavoidable with Mitigation
Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative								
Paleontologic Resources								
Potential Impact 3.13-1. The Proposed Project could result in substantial adverse effects on, or destruction of, High Potential Paleontologic Resources through exposure or slope failure.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Land Use and Planning								
Potential Impact 3.14-1. Removal of the reservoirs, construction-related traffic, and/or land transfer could change connectivity between areas of a community.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.14-2. The Proposed Project would not conflict with an applicable land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect in a manner that would prevent the avoidance or mitigation result sought to be achieved by the plan, policy, or regulation.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Agriculture and Forestry Resources								
Potential Impact 3.15-1. Conversion of farmland to non-agricultural use or conflict with Williamson Act land or agricultural zoning.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.15-2. Conversion of forest lands to non-forest use or conflict with forest zoning.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				

Geographic or Other Additional Information (as needed)	Time Frame[1]		Beneficial	No Significant Impact[2]	Mitigation	No Significant Impact with Mitigation	Significant and Unavoidable	Significant and Unavoidable with Mitigation
Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative								
Potential Impact 3.15-3. Indirect conversion of farmland to non-agricultural use or forest land to non-forest use.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.15-4. Other changes in the existing environment that could result in conversion of farmland to non-agricultural use or conversion of forest land to non-forest use.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Population and Housing								
Potential Impact 3.16-1. Inducing substantial unplanned population growth in an area, either directly or indirectly.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.16-2. Displacement of substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Public Services								
Potential Impact 3.17-1. Increased public service response times for emergency fire, police, and medical services due to construction and demolition activities. *								
	S			NP	HZ-1			PP, PR, CO, 2R, 3R, NH

Potential Impacts
PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative

Geographic or Other Additional Information (as needed)	Time Frame[1]		Beneficial	No Significant Impact[2]	Mitigation	No Significant Impact with Mitigation	Significant and Unavoidable	Significant and Unavoidable with Mitigation
Potential Impact 3.17-2. The Proposed Project's elimination of a long-term water source for wildfire services could substantially increase the response time for suppressing wildfires. *								
	S			PP, NP, PR, CO, 2R, 3R, NH				
		L		CO				PP, PR, 2R, 3R, NH
Potential Impact 3.17-3. Potential effects on school services and facilities.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Utilities and Service Systems								
Potential Impact 3.18-1. The Proposed Project could result in the construction of new wastewater treatment facilities or expansion of existing facilities, due to inadequate capacity to serve the Proposed Project's anticipated demand or where the construction of such facilities could cause significant environmental impacts.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.18-2. The Proposed Project could require or result in the construction of new stormwater drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental impacts.								
	S			PP, PR, CO, 2R, 3R, NH				
Potential Impact 3.18-3. The Proposed Project could exceed permitted landfill capacity to accommodate the project's solid waste disposal needs.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.18-4. The Proposed Project could violate applicable statutes and regulations related to solid waste.								
	S			PP, NP, PR, CO, 2R, 3R, NH				

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Aesthetics								
Potential Impact 3.19-1. Loss of Open Water Vistas.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.19-2. Changes in Flows and Channel Morphology.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				
Potential Impact 3.19-3. Changes in Visual Water Quality.								
Turbidity and reduced clarity	S			PP, NP, PR, CO, 2R, 3R, NH				
Reduced algal blooms		L	PP, PR, 2R, 3R, NH	CO				
Potential Impact 3.19-4. Visual changes resulting from reservoir drawdown and restoration including temporarily bare/unvegetated banks.								
	S			NP, CO			PP, PR, 2R, 3R, NH	
		L		PP, PR, CO, 2R, 3R, NH				
Potential Impact 3.19-5. Visual changes resulting from the removal of Lower Klamath Project dams and associated facilities and improvements to or construction of new infrastructure.								
Removal of Lower Klamath Project dams and associated facilities		L		PP, PR, 2R, 3R, NH, CO				
Improvements to and construction of new infrastructure		L		PP, PR, 2R, 3R, CO				

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Iron Gate Hatchery		L	NH					
New recreation facilities		L		CO			PP, PR, 2R, 3R, NH	
Potential Impact 3.19-6. Short-term visual impacts of construction activities/equipment.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.19-7. The Project's construction or security lighting could result in new sources of substantial light or glare that would adversely affect nighttime views in the area.								
	S			NP, CO			PP, PR, CO, 2R, 3R, NH	
Recreation								
Potential Impact 3.20-1. Effects on existing recreational facilities and opportunities due to access restrictions, noise, dust, and/or sediment release resulting from construction activities.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.20-2. Long-term changes to or loss of reservoir-based recreation activities and facilities due to removal of Iron Gate and Copco No. 1 reservoirs.								
		L		PP, PR, CO, 2R, 3R, NH				
Potential Impact 3.20-3. Significant increase in the use of regional recreational facilities due to loss of Iron Gate and Copco No. 1 reservoirs, such that substantial physical deterioration or acceleration of deterioration of the regional facilities would occur.								
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH				

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative									
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**	
Potential Impact 3.20-4. Effects on the environment due to construction of new or expansion of existing recreational facilities.									
	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH					
Potential Impact 3.20-5. Changes to or loss of river conditions that support whitewater boating.									
Middle and Lower Klamath River	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH					
Hell's Corner Reach	S	L		NP (S only)			PP, PR, CO, 2R, 3R, NH		
Potential Impact 3.20-6. Changes to or loss of other river-based recreation including fishing.									
Middle Klamath River between Iron Gate Dam (RM 193.1) and Humbug Creek (RM 174.3)	S	L		PP, NP (S only), PR, CO, 2R, 3R, NH					
Hydroelectric Reach, Middle Klamath River downstream of Humbug Creek (RM 174.3), and the Lower Klamath River	S	L	PP, PR, 2R, 3R, NH, CO	NP (S only)					
Potential Impact 3.20-7. Effects on Wild and Scenic River resources, designations, or eligibility for listing.									
Designated California Klamath River wild and scenic river segment, and eligible and suitable California Klamath River wild and scenic river section	S			PP, NP, PR, CO, 2R, 3R, NH					
Designated California Klamath River wild and scenic river segment, and eligible and suitable California Klamath River wild and scenic river section		L	PP, PR, 2R, 3R, NH	CO					

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Hazards and Hazardous Materials								
Potential Impact 3.21-1. Proposed construction-related activities could result in substantial exposure to hazardous materials through the routine transport, use, or disposal of hazardous materials.								
	S			NP	HZ-1	PP, PR, CO, 2R, 3R, NH		
Potential Impact 3.21-2. Proposed construction-related activities could result in substantial exposure to hazardous materials through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment.								
	S			NP	HZ-1	PP, PR, CO, 2R, 3R, NH		
Potential Impact 3.21-3. Proposed construction-related activities could result in substantial exposure to hazardous materials through emissions or handling of substances or waste within one-quarter mile of an existing or proposed school.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.21-4. The Proposed Project could be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, could result in substantial exposure to hazardous materials.								
	S			NP	HZ-1	PP, PR, CO, 2R, 3R, NH		
Potential Impact 3.21-5. The Proposed Project could result in, for a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, a substantial safety hazard for people residing or working in the project area due to a risk of traffic accidents.								
	S			PP, NP, PR, CO, 2R, 3R, NH				

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.21-6. The Proposed Project could result in, for a project within the vicinity of a private airstrip, a substantial safety hazard for people residing or working in the project area due to a risk of traffic accidents.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.21-7. Proposed construction-related activities could impair implementation of, or physically interfere with, an adopted emergency response plan or emergency evacuation plan. *								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.21-8. Proposed construction-related activities and/or removal of the Lower Klamath Project reservoirs could substantially increase the public's risk of loss, injury or death associated with wildland fires.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
		L		CO			PP, PR, 2R, 3R, NH	
Transportation and Traffic								
Potential Impact 3.22-1. Proposed construction-related traffic could potentially result in a substantial increase in traffic in excess of the capacity or design of the road improvements or impairs the safety or performance of the circulation system, including transit, roadways, bicycle lanes and pedestrian paths. *								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.22-2. Proposed construction-related traffic could potentially conflict with an applicable congestion management program, including, but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways that would result in increased risk of harm to the public. *								
	S			NP			PP, PR, CO, 2R, 3R, NH	

Potential Impacts **PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative**								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.22-3. Proposed construction-related traffic could result in substantially increasing hazards due to a design feature (e.g., sharp curves or narrow lanes) or incompatible uses (e.g., oversized construction equipment) that would result in an increased risk of harm to the public. *								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.22-4. The Proposed Project could result in inadequate emergency access that would result in an increased risk of harm to the public. *								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.22-5. Construction-related activities could potentially conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities resulting in an increased risk of harm to the public. *								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.22-6. The Proposed Project could potentially result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Noise								
Potential Impact 3.23-1. Use of standard construction equipment could exceed Siskiyou County General Plan criteria for maximum allowable noise levels from construction equipment.								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.23-2. Construction activities at Copco No. 1 Dam could cause short-term increases in daytime and nighttime noise levels affecting nearby residents.								
	S			NP			PP, PR, CO, 2R, 3R, NH	

Potential Impacts PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage; 2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.23-3. Construction activities at Copco No. 2 Dam could cause short-term increases in noise levels affecting nearby residents.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.23-4. Construction activities at Iron Gate Dam could cause short-term increases in nighttime noise levels affecting nearby residents.								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.23-5. Reservoir restoration activities at Copco No. 1 and Iron Gate could result in short-term increases in noise levels affecting nearby residents.								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.23-6. Blasting activities at Copco No. 1, Copco No. 2, and Iron Gate Dams could increase daytime vibration levels affecting nearby residents.								
	S			NP			PP, PR, CO, 2R, 3R, NH	
Potential Impact 3.23-7. Transporting waste to off-site landfills and construction worker commutes could cause increases in traffic noise along haul routes affecting nearby residents.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.23-8. Construction activities associated with the Downstream Flood Control project component (moving or elevating legally established structures with flood risk) could produce noise and vibration associated with construction activities.								
	S			PP, NP, PR, CO, 2R, 3R, NH				
Potential Impact 3.23-9. Construction activities associated with implementation of Mitigation Measure WSWR-1 (modify water intakes) could produce noise and vibration associated with construction activities.								
	S			PP, NP, PR, CO, 2R, 3R, NH				

Potential Impacts **PP = Proposed Project; NP = No Project Alternative; PR = Partial Removal Alternative; CO = Continued Operations with Fish Passage;** **2R = Two Dam Removal Alternative; 3R = Three Dam Removal Alternative; NH = No Hatchery Alternative**								
Geographic or Other Additional Information (as needed)	**Time Frame[1]**		**Beneficial**	**No Significant Impact[2]**	**Mitigation**	**No Significant Impact with Mitigation**	**Significant and Unavoidable**	**Significant and Unavoidable with Mitigation**
Potential Impact 3.23-10. Construction activities associated with the deepening or replacement of existing groundwater wells adjacent to the reservoirs could produce noise and vibration affecting nearby residents.								
	S			PP, NP, PR, CO, 2R, 3R, NH				

[1] S = short term potential impact; L = long term potential impact; time frames for "S" and "L" are defined by alternative and resource area.

[2] No significant impact - potential effect either would not cause any adverse alterations to existing conditions or would cause alterations but they would not result in a significant adverse effect (includes determinations of no impact, less than significant impact, no change from existing adverse conditions, no change from existing conditions).

* Indicates a *Significant and Unavoidable Impact* that would be reduced to *No Significant Impact with Mitigation* if one or more Recommended Measures were to be implemented. Due to federal preemption the State Water Board cannot guarantee the implementation of Recommended Measures.

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1 INTRODUCTION

1.1 Authorization, Purpose, and Use of EIR

The Klamath River Renewal Corporation (KRRC) has applied to the Federal Energy Regulatory Commission (FERC) to decommission and remove the four Lower Klamath Project dams and associated facilities to create a free-flowing Klamath River and provide for volitional fish passage in the Klamath River.

FERC is the federal agency that licenses the construction, operation, and decommissioning of most non-federal hydroelectric dams in the United States. The KRRC has applied to FERC to surrender the hydropower license for the Lower Klamath Project. Under section 401 of the federal Clean Water Act, the KRRC has applied to the State Water Resources Control Board (State Water Board) for certification of whether − and under what conditions − the proposed dam removal can comply with California's water quality standards. FERC incorporates the terms of any water quality certification into the licenses or surrender orders it issues.

The State Water Board is the Lead Agency responsible for complying with the California Environmental Quality Act (CEQA)[5] for the Lower Klamath Project License Surrender (Proposed Project). This environmental impact report (EIR) was prepared in conformance with CEQA. CEQA requires the Lead Agency to prepare an EIR when there is substantial evidence that a project could have a significant effect on the environment.

This EIR focuses on impacts related to actions proposed in the California portion of the Lower Klamath Project (FERC Project No. 14803) located along the Klamath River in Siskiyou County, California, including the Copco No. 1, Copco No. 2, and Iron Gate dam complexes. Actions at the J.C. Boyle dam complex, located in Klamath County, Oregon, and other actions of the Proposed Project in Oregon will be described in general terms, but the discussion of environmental impacts in this EIR will be limited to those with the potential to adversely impact the California environment. On September 7, 2018, Oregon's Department of Environmental Quality (ODEQ) issued a water quality certification based on a separate certification application for the Lower Klamath Project that addresses water quality impacts in Oregon from the Proposed Project, including removal of the J.C. Boyle dam complex. FERC and other federal agencies are analyzing impacts of the Proposed Project in both states.

The purpose of this EIR is to inform the public and decision makers of the significant environmental effects of the Proposed Project, to identify possible ways to minimize those effects, and to describe reasonable alternatives that would feasibly attain most, if not all of the basic objectives of the Proposed Project (Section 2.1 *Project Objectives*).

The EIR process is specifically designed to evaluate and disclose the potentially significant direct, indirect, and cumulative effects of the Proposed Project, and to describe reasonable alternatives to the Proposed Project that could avoid or reduce those effects, while feasibly attaining most, if not all, of the Proposed Project's basic objectives (Section 2.1 *Project Objectives*).

[5] Public Resources Code, sections 21000 et seq.

1.1.1 CEQA Guidance Regarding State Boundaries

Public Resources Code, section 21080, subdivision (b) (14), establishes that CEQA does not apply to "*any project or portion thereof located in another state which will be subject to environmental impact review pursuant to the National Environmental Policy Act (NEPA) of 1969* (42 U.S.C. Sec. 4321 et seq.) or similar state laws of that state. Any emissions or discharges that would have a significant effect on the environment in this state are subject to [CEQA]."

Since the Proposed Project is required to comply with NEPA, this EIR does not evaluate portions of the Proposed Project in Oregon. There are two exceptions to this approach:

1. This EIR evaluates portions of the Proposed Project in Oregon for which the impacts may cross into California and potentially affect California resources. These impacts are evaluated starting at the Oregon-California state line. For example, removal of J.C. Boyle Dam in Oregon, which is part of the Proposed Project and some alternatives, would affect hydrology and water quality in California.
2. This EIR examines potential significant Project-related impacts to California environmental resources (e.g., anadromous fish) that move into Oregon and subsequently move back into California as a result of the Proposed Project or alternatives.

1.2 Brief Introduction to the Proposed Project

The Proposed Project is a restoration project on the Klamath River to decommission and remove four hydroelectric dams and implement of a range of associated measures. The Proposed Project includes removal of the dams and associated facilities, road improvements, modifications to hatcheries, restoration activities, and measures to address some of the potential environmental and quality-of-life impacts of the restoration project. The hydroelectric dams proposed for removal are Copco No. 1 Dam ([River Mile [RM] 201.8), Copco No. 2 Dam (RM 201.5), and Iron Gate Dam (RM 193.1) in Siskiyou County, California and J.C. Boyle Dam (RM 229.8), in Klamath County, Oregon (see Figure 2.2-1). Together, these dams and their associated facilities constitute the Lower Klamath Project (FERC Project No. 14803). Please see Section 2 *Proposed Project* for more detailed information.

1.3 Scope and Content of the EIR

This EIR evaluates the environmental impacts of the Proposed Project relative to a number of environmental issue areas. This EIR provides information in accordance with CEQA Guidelines sections 15120 to 15132, as follows.

Volume I

Section 1 Introduction – This section introduces the EIR with information on: authorization, purpose, and use of the EIR; brief introduction to the Proposed Project; scope and content of the EIR; EIR process overview; and public involvement and agency consultation during preparation of the EIR.

Section 2 Project Description – This section provides a summary description of the Proposed Project, including Proposed Project objectives; location; existing features; surrounding land ownership, land use, and land cover; background information on Klamath Basin water conflicts, the relationship between the Proposed Project and other local hydroelectric facilities, Klamath Basin settlement agreements, and prior/related environmental reviews; Proposed Project components including, but not limited to, schedule, deconstruction activities, restoration activities, and operation of hatcheries; and intended uses of the EIR.

Section 3 Environmental Setting, Potential Impacts, and Mitigation Measures – This section provides a description of the environmental setting for all relevant issue areas. Significance criteria for the impact analyses are presented by issue area. As applicable, the issue areas address compliance with relevant plans. Each resource area analyzes potential impacts, along with potential mitigation measures for significant impacts. This section evaluates the impacts as either having no significant impact, no significant impact with mitigation, significant and unavoidable impact, significant and unavoidable with mitigation, or a beneficial effect. The potential incremental impacts of the Proposed Project when combined with other closely related past, present, and reasonably foreseeable future projects (i.e., cumulative impacts) are also analyzed in this section.

Section 4 Alternatives – This section provides a discussion of the selection of a range of reasonable alternatives to the Proposed Project. For each alternative carried forward for analysis in this EIR, the potential environmental impacts are analyzed by resource area, including analysis of potential mitigation measures for significant impacts.

Section 5 Other CEQA Considerations – This section provides an evaluation of irreversible and irretrievable commitment of resources and potential growth-inducing impacts and discusses consideration of social and economic factors under CEQA.

Volume II

Technical Appendices – This volume includes all technical appendices to the EIR.

1.4 EIR Process Overview

As Lead Agency, the State Water Board made the determination to prepare an EIR based on a preliminary evaluation of the potential environmental effects of the Proposed Project. The State Water Board issued a Notice of Preparation on December 22, 2016 (please see Section 1.5.1 *Scoping Meetings* for a description of scoping and other meetings to solicit public and agency input).

Stillwater Sciences[6], the State Water Board's CEQA contractor, then prepared working draft documents at the direction of State Water Board staff. State Water Board staff reviewed these working drafts, and comments and revisions were incorporated to constitute the Draft EIR.

This Draft EIR is being circulated for agency and public review. The comment period concludes at 12:00 p.m. on February 26, 2019. During the comment period, the State Water Board will also hold four public meetings on the Draft EIR, as described in the Notice of Availability of a Draft EIR. The State Water Board will review all comments received on the Draft EIR and will prepare written responses to comments raising significant environmental issues, consistent with the requirements of CEQA Guidelines section 15088. The Final EIR will include responses to comments and any changes to the Draft EIR. Written responses will be sent to those public agencies that provided timely comments on the EIR at least 10 days prior to certification of the Final EIR.

The State Water Board will review and consider the EIR, including comments and responses prior to making a decision on issuance of a water quality certification. If the State Water Board concludes that the EIR reflects the State Water Board's independent judgment and has been prepared in accordance with CEQA and the CEQA Guidelines, the State Water Board will certify the Final EIR (CEQA Guidelines section 15090). The State Water Board will make findings regarding each significant effect identified in the EIR (Pub. Resc. Code, sec. 21081). The State Water Board will consider the information in the EIR, along with any other available information, in making its decision on whether and under what conditions to issue water quality certification for the Lower Klamath Project (CEQA Guidelines section 15121).

1.5 Public Involvement and Agency Consultation in Preparing Draft EIR

The State Water Board received invaluable input from public stakeholders and other federal, state, and local agencies and Native American Tribes in the development of its Draft EIR.

As part of the environmental review process, the State Water Board issued its *Notice of Preparation and Scoping Meetings for an Environmental Impact Report for the Lower Klamath Project License Surrender* (NOP) on December 22, 2016. The NOP was out for a 42-day public comment period from December 22, 2016 to February 1, 2017 (see also Appendix A). The State Water Board held three public scoping meetings in the cities of Arcata, Sacramento, and Yreka in January 2017 to solicit public and stakeholder input. The State Water Board notified all relevant agencies on the State Clearinghouse list of potential responsible and trustee agencies, as well as interested groups, organizations, and individuals, that the State Water Board would prepare an EIR for the Proposed Project, and published notice of the scoping meetings and of issuance of the Notice of Preparation in the Siskiyou Daily, Eureka Times Standard, and Sacramento Bee.

The State Water Board also engaged in robust consultation with other public agencies and Native American Tribes, as detailed below in Section 1.5.3.

[6] Stillwater Sciences is the primary consultant firm developing this EIR at the direction of the State Water Board. Additional consultants supporting Stillwater Sciences include SHN Engineers and Geologists, and William Rich and Associates.

The State Water Board issued a Scoping Report (see Appendix A), which documents the scoping process, including the NOP, the content of the public scoping meetings and all comments received. A summary of the scoping meetings and environmental issues raised during this public involvement process follows.

1.5.1 Scoping Meetings

The State Water Board recognizes the complex and controversial nature of the proposed Lower Klamath Project; that different communities along the Klamath River have different input to provide, and that travel for community members might be difficult. In this context, valuable community input may have been lost under CEQA's minimum requirement of one scoping meeting. To facilitate community input, the State Water Board conducted three scoping meetings during the NOP comment period.

Table 1.5-1. Public Scoping Meetings – Dates and Locations.

Arcata, CA
January 12, 2017 (5:00 pm–7:00 pm) D Street Neighborhood Center 1301 D Street Arcata, CA 95521
Sacramento, CA
January 20, 2017 (10:00 am–12:00 pm) CalEPA Building – Byron Sheet Auditorium 1001 I Street, 2nd Floor Sacramento, CA 95814
Yreka, CA
January 26, 2017* (5:00 pm–7:00 pm) Best Western Miner's Inn – Convention Center, Auditorium 122 E. Miner Street Yreka, CA 96097

* The Yreka public scoping meeting was originally scheduled for January 10, 2017. On January 9, 2017, the State Water Board canceled the Yreka scoping meeting due to inclement weather and a strong advisory against travel from the National Oceanic and Atmospheric Administration's National Weather Service. On January 10, 2017, the State Water Board rescheduled the Yreka scoping meeting for January 26, 2017.

1.5.2 Scoping Comments

The State Water Board received 83 oral and eight written comments during the public scoping meetings, as well as over 1,300 written comments submitted via email or letter. All comments referenced in the Scoping Report were considered in development of the EIR.

The Scoping Report summarizes the issues raised under each of the topics and provides the text of both oral and written comments (Appendix A, Scoping Report, section 4.2). Scoping comments addressed a wide range of environmental and other issues, which are listed below:

- Overall EIR scope
- Environmental baseline
- KRRC's Proposed Project
- No Project Alternative
- Other project alternatives suggested during scoping
- Incorporation of findings from past studies
- Fish/fisheries
- Water quality
- Water supply
- Hydrology
- Sediment
- Recreation
- Economics
- Property value
- Tribal cultural and historical resources
- Paleontologic resources
- Energy production and greenhouse gases
- Wildlife
- Riparian habitat
- Agriculture
- Public health and safety
- Aesthetics
- Environmental law compliance
- Cumulative impact analysis
- Source data and information
- Other comments
- Comments not relating to the scope or content of the EIR

1.5.3 Agency and Tribal Consultation

Consistent with CEQA Guidelines, section 21104(a), as part of the EIR development, the State Water Board consulted with and obtained comments from public agencies that have expertise related to the Proposed Project, and the county in the Proposed Project location. Similarly, consistent with Public Resources Code section 21080.3.1, the State Water Board consulted with California Native American Tribes traditionally and culturally affiliated with the geographic area of the Proposed Project who requested consultation. A short description of the consultations with each agency and tribes is outlined below:

CALFIRE:

- Hosted a conference call with CALFIRE staff on November 6, 2018, to discuss Lower Klamath Project dam removal and current firefighting methods in Siskiyou County.

California Coastal Commission

- Attended a public meeting with Coastal Commission staff on April 13, 2017, and associated email communications.

California Department of Fish and Wildlife (CDFW)

- Regular in-person meetings and coordination calls, including participation in KRRC Technical Workgroup Inter-agency meetings.

California Natural Resources Agency

- Regular coordination calls.

National Marine Fisheries Service (NMFS)

- Coordination calls, as needed, including participation in KRRC Technical Workgroup Inter-agency meetings.

Native American Tribes

- Series of tribal consultation meetings under Assembly Bill 52[7] with Shasta Nation, Shasta Indian Nation, and Yurok Tribe.
- In-person meetings with the Karuk Tribe and Hoopa Valley Tribe

North Coast Regional Water Quality Control Board

- Various meetings and emails.
- Attended in-person North Coast Regional Water Quality Control Board meeting in City of Weed on April 19, 2018, with State Water Board Member Steve Moore.

Oregon Department of Environmental Quality

- Regular telephonic communications.

[7] Statutes 2014, Chapter 532, Gatto.

Siskiyou County

- July 11, 2017 – State Water Board staff and State Water Board member Steve Moore, attended a public meeting of the Siskiyou County Board of Supervisors and presented on the status of the Draft EIR.
- April 19, 2018 – in-person meeting with County's designated contact and consultants.
- August 14, 2018 – State Water Board staff attended a public meeting of the Board of Supervisors and presented on the status of the draft EIR.

United States Bureau of Reclamation (USBR)

- Coordination calls, as needed.

United States Fish and Wildlife Service (USFWS)

- Coordination calls, as needed, including participation in KRRC Technical Workgroup Inter-agency meetings.

United States Geological Survey (USGS)

- Coordination calls, as needed.

2 PROPOSED PROJECT

This chapter describes the Lower Klamath Project License Surrender (Proposed Project) pursuant to the requirements of CEQA Guidelines Section 15124.

2.1 Project Objectives

The State Water Board has identified the following Proposed Project objectives, as required under CEQA Guidelines, section 15124, subdivision (b):

In a timely manner:

1. Improve the long-term water quality conditions associated with the Lower Klamath Project in the California reaches of the Klamath River, including water quality impairments due to *Microcystis aeruginosa* and associated toxins, water temperature, and levels of biostimulatory nutrients.
2. Advance the long-term restoration of the natural fish populations in the Klamath Basin, with particular emphasis on restoring the salmonid fisheries used for subsistence, commerce, tribal cultural purposes, and recreation.
3. Restore volitional anadromous fish passage in the Klamath Basin to viable habitat currently made inaccessible by the Lower Klamath Project dams.
4. Ameliorate conditions underlying high disease rates among Klamath River salmonids.

These objectives further the underlying purpose of timely improving water quality related to the Lower Klamath Project within and downstream of the current Hydroelectric Reach and restoring anadromous access upstream of Iron Gate Dam (the current barrier to anadromy).

2.2 Project Location

The Proposed Project is located on the Klamath River in Siskiyou County, California and in Klamath County, Oregon (Figure 2.2-1). The nearest city to the California portion of the Proposed Project is Yreka, which is located 20 miles southwest of the downstream end of the Proposed Project.

The California portion of the Proposed Project includes the following three dams and associated facilities: Iron Gate Dam (RM 193.1), Copco No. 1 Dam (RM 201.8), and Copco No. 2 Dam (RM 201.5). The Klamath Basin—comprised of the Upper Klamath Basin, Mid-Klamath Basin, and Lower Klamath Basin—and the mainstem Klamath River reaches are shown in Figure 2.2-2. For purposes of this draft EIR, the California portion of the Klamath River system has been divided into four (4) reaches as follows: Hydroelectric Reach, Middle Klamath River, Lower Klamath River, and Klamath River Estuary. The Hydroelectric Reach extends into Oregon, where upstream reaches of the Klamath River also include the Upper Klamath River, Keno Reservoir, Lake Ewauna, and Link River (Figure 2.2-3).

The State Water Board has identified the Project Boundary as inclusive of the Proposed Project “Limits of Work” as well as PacifiCorp lands immediately surrounding the Lower Klamath Project (“Parcel B lands”) that would be transferred as part of the Proposed

Project. The boundary for the entire Proposed Project, including the Oregon portion of the Proposed Project surrounding the J.C. Boyle Dam and associated facilities and the California portion of the Proposed Project surrounding the Iron Gate, Copco No. 1, and Copco No. 2 dams and associated facilities, are shown in Figure 2.2-4. The California portion of the Project Boundary is shown in Figure 2.2-5. The transfer and disposition of Parcel B lands under the Proposed Project is discussed further in Section 2.7.10 *Land Disposition and Transfer* of this EIR.

Throughout this EIR, information concerning the Oregon portion of the Proposed Project is provided for context, although CEQA does not apply to impacts or actions Oregon except to the extent that there are emissions or discharges that would significantly impact the California environment (see also Section 1.1.1 *CEQA Guidance Regarding State Boundaries*).

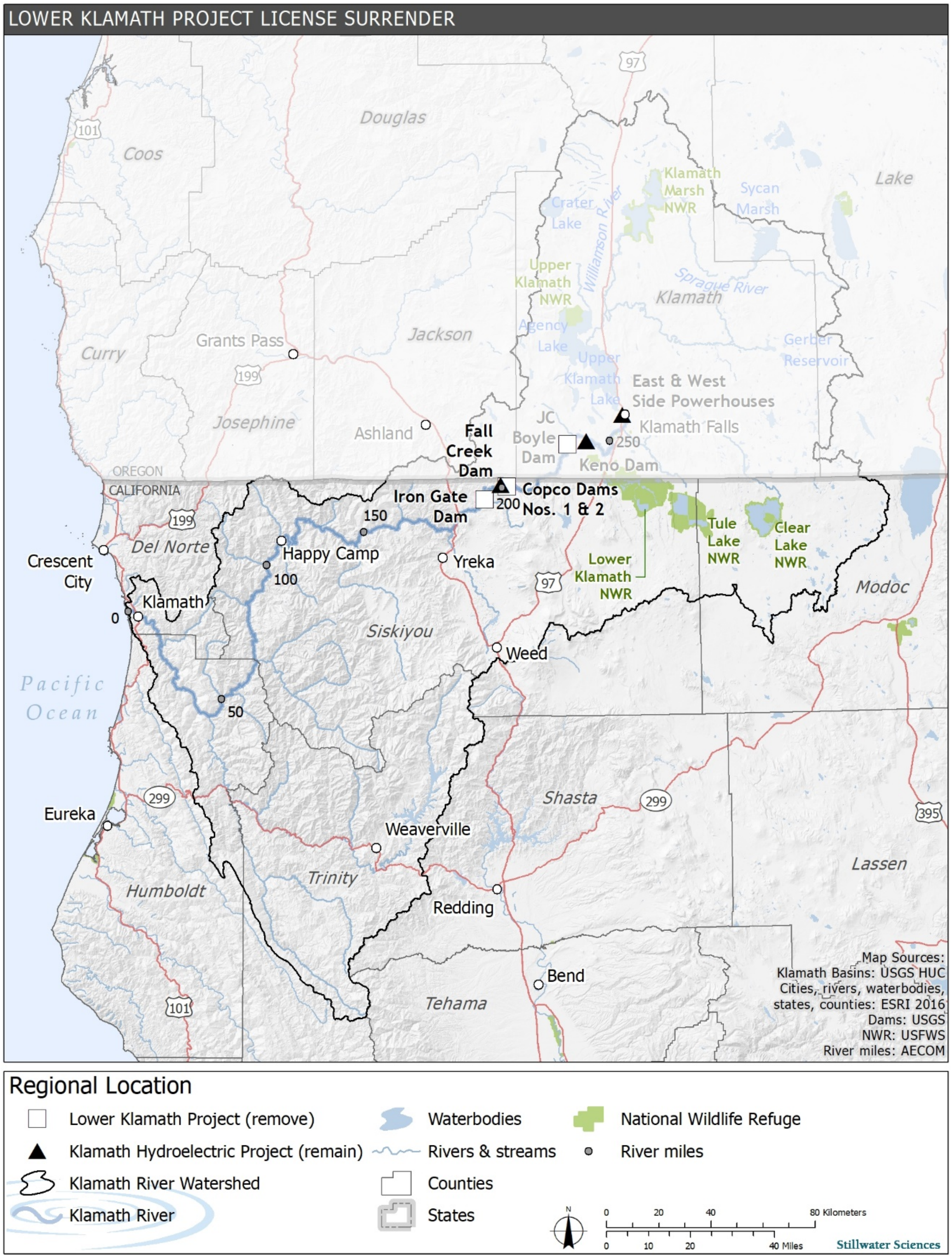

Figure 2.2-1. Regional Location.

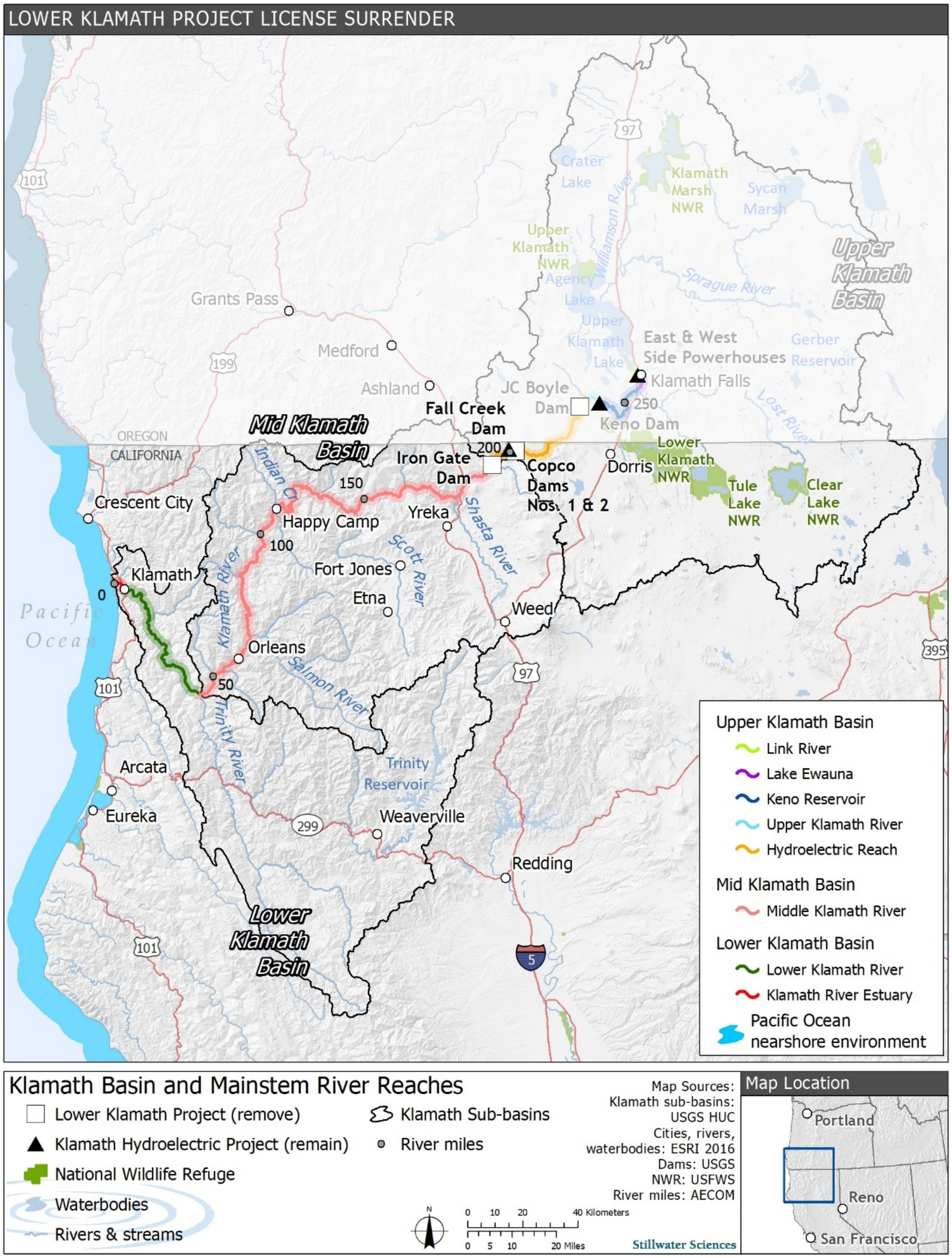

Figure 2.2-2. Klamath Basin and Mainstem River Reaches.

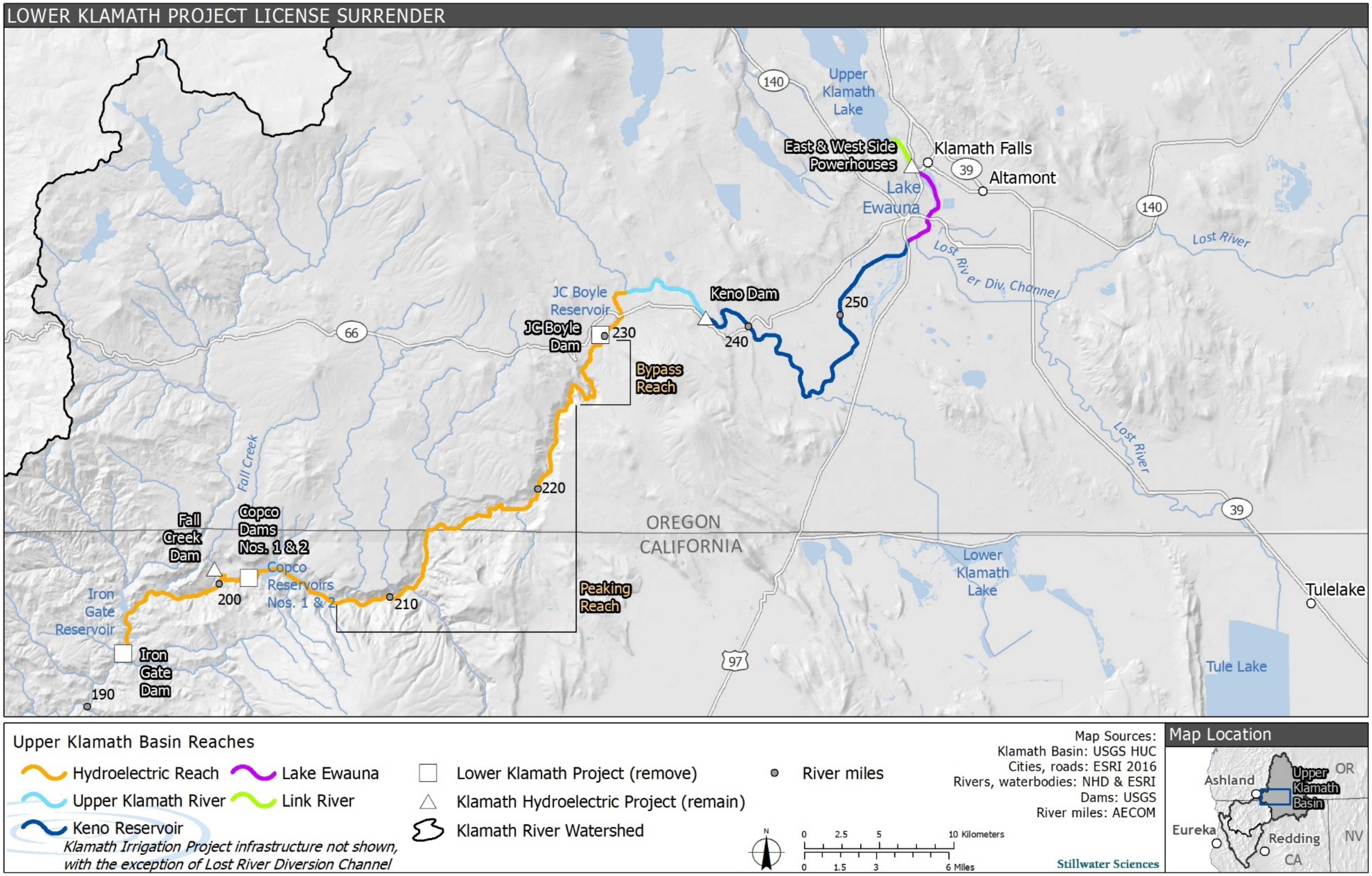

Figure 2.2-3. Upper Klamath Basin Reaches.

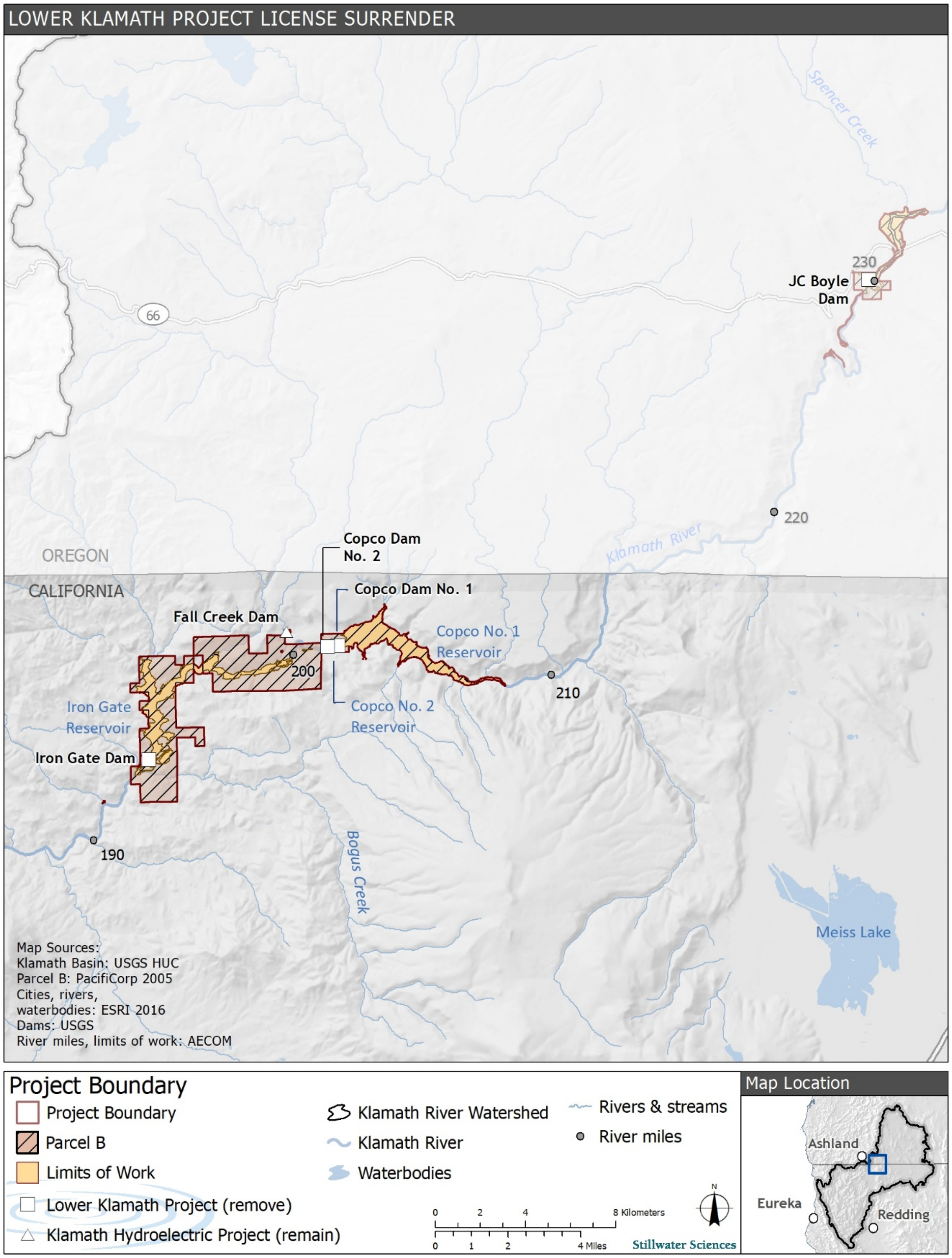

Figure 2.2-4. Proposed Project Boundary.

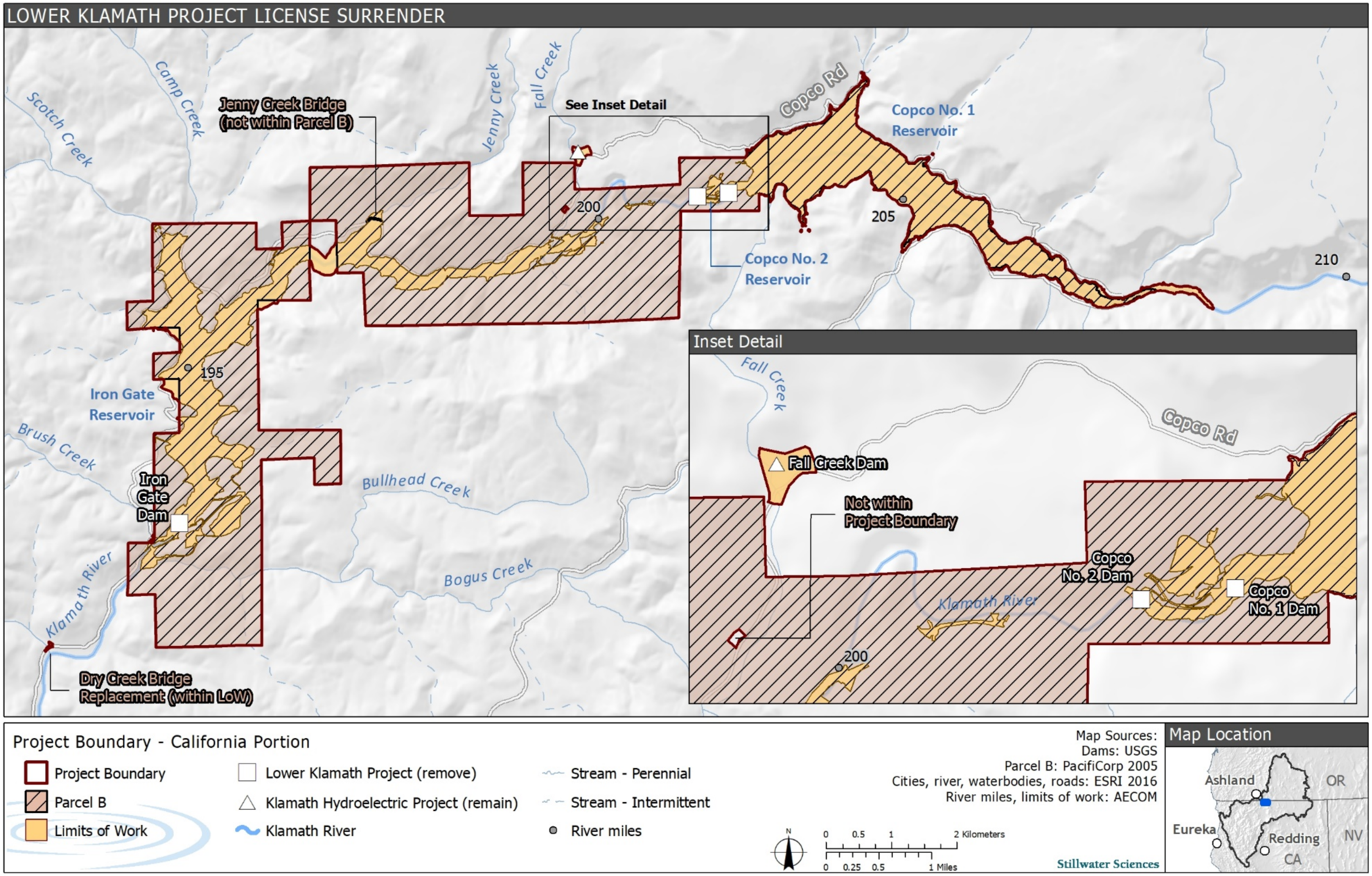

Figure 2.2-5. Proposed Project Boundary – California Portion.

2.3 Existing Lower Klamath Project Features

Basic features of the Lower Klamath Project (e.g., dams and powerhouse components) are summarized in Table 2.3-1 and described in the following sections. A brief description of J.C. Boyle Dam and its associated facilities, which are located in Oregon, is provided to inform any evaluations of impacts to resources in California that are affected by the portion of the Proposed Project that is in Oregon (see also Section 1.1.1 *CEQA Guidance Regarding State Boundaries*).

Table 2.3-1. Lower Klamath Project Dam and Powerhouse Components.

	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate
Dam type	Concrete and earthfill embankment	Concrete	Concrete	Earthfill embankment
Dam maximum height	68 feet	133 feet	32 feet	189 feet
Dam crest length	430 feet	410 feet	305 feet	740 feet
Reservoir surface area	350 acres	972 acres	N/A	942 acres
Reservoir storage volume	2,267 acre-feet	33,724 acre-feet	70 acre-feet	50,941 acre-feet
Type of facility to allow water to flow past dam	Overflow spillway with control gates and diversion culvert	Overflow spillway with larger control gate and modified diversion tunnel	Overflow spillway with control gates	Uncontrolled overflow spillway and diversion tunnel

Source: Appendix B: *Definite Plan*. Note that component dimensions have been adjusted from those reported in FERC 2007 and USBR 2012a based on available data (e.g., as-built drawings, aerial photographs, topographic information).

2.3.1 J.C. Boyle Dam and Associated Facilities

The J.C. Boyle Dam (RM 229.8) and associated facilities are in Oregon on the mainstem of the Klamath River at the upstream end of the Hydroelectric Reach. J.C. Boyle Dam is a 68-foot tall concrete and earthfill dam that was completed in 1958. The dam impounds approximately 2,267-acre feet of water in a narrow reservoir with a surface area of approximately 350 acres, with a fish ladder along its concrete spillway[8] (Figure 2.3-1). J.C. Boyle Reservoir supplies water through a conveyance system that extends 2.5 miles from the dam to a 98-megawatt (MW) powerhouse. Water diversions for hydropower generation at J.C. Boyle Dam create a sub-reach of the Hydroelectric Reach called the Bypass Reach, which is located immediately downstream of the dam and extends to the powerhouse at RM 225.2 (Figure 2.3-1). The Bypass Reach contains less flow than other sections of the Klamath River due to water diversions for J.C. Boyle hydropower operations. Article 34 of the 1957 amended license requires a reasonable minimum flow, which was later set to 100 cfs by FERC, to be maintained in the Bypass

[8] The existing concrete upstream fish ladder on the north side of the J.C. Boyle Dam spillway does not meet current design criteria and must be replaced because of its configuration and poor structural condition (2012 KHSA EIS/EIR).

Reach. After diverted water runs through the J.C. Boyle power generation facilities, it rejoins the Klamath River (RM 225.2).

Another sub-reach of the Hydroelectric Reach is located downstream of the J.C. Boyle Powerhouse and is referred to as the Peaking Reach because the powerhouse is generally operated as a peaking facility to generate power during peak demand periods. During peaking operations, water stored in J.C. Boyle Reservoir is diverted around the Bypass Reach to the powerhouse to provide enough flow to generate hydropower and to take advantage of the cost difference between peak and off-peak power generation. Peaking occurs at J.C. Boyle Powerhouse when there is not sufficient river flow to sustain continuous hydropower operations, especially during the summer and fall low flow period. Power demand peaks during weekday afternoons in the summer, thus peaking power generation occurs in the late afternoons and early evenings to meet this demand. J.C. Boyle Reservoir refills during the night when power demand is minimal. Figure 2.3-2 illustrates early summer flows in 2011 as an example of how peaking operations affect flow downstream from the powerhouse, fluctuating rapidly to meet demand and peaking operations for power generation. During peaking operations, the rise or fall of the Klamath River is increased or decreased gradually at a rate not to exceed 9 inches per hour at a point located 0.5 miles downstream of the J.C. Boyle Powerhouse. Peaking operations result in a rise or fall of the river over a period of three to four hours. The Peaking Reach crosses from Oregon into California and ends at the Copco No. 1 Reservoir (RM 208.3).

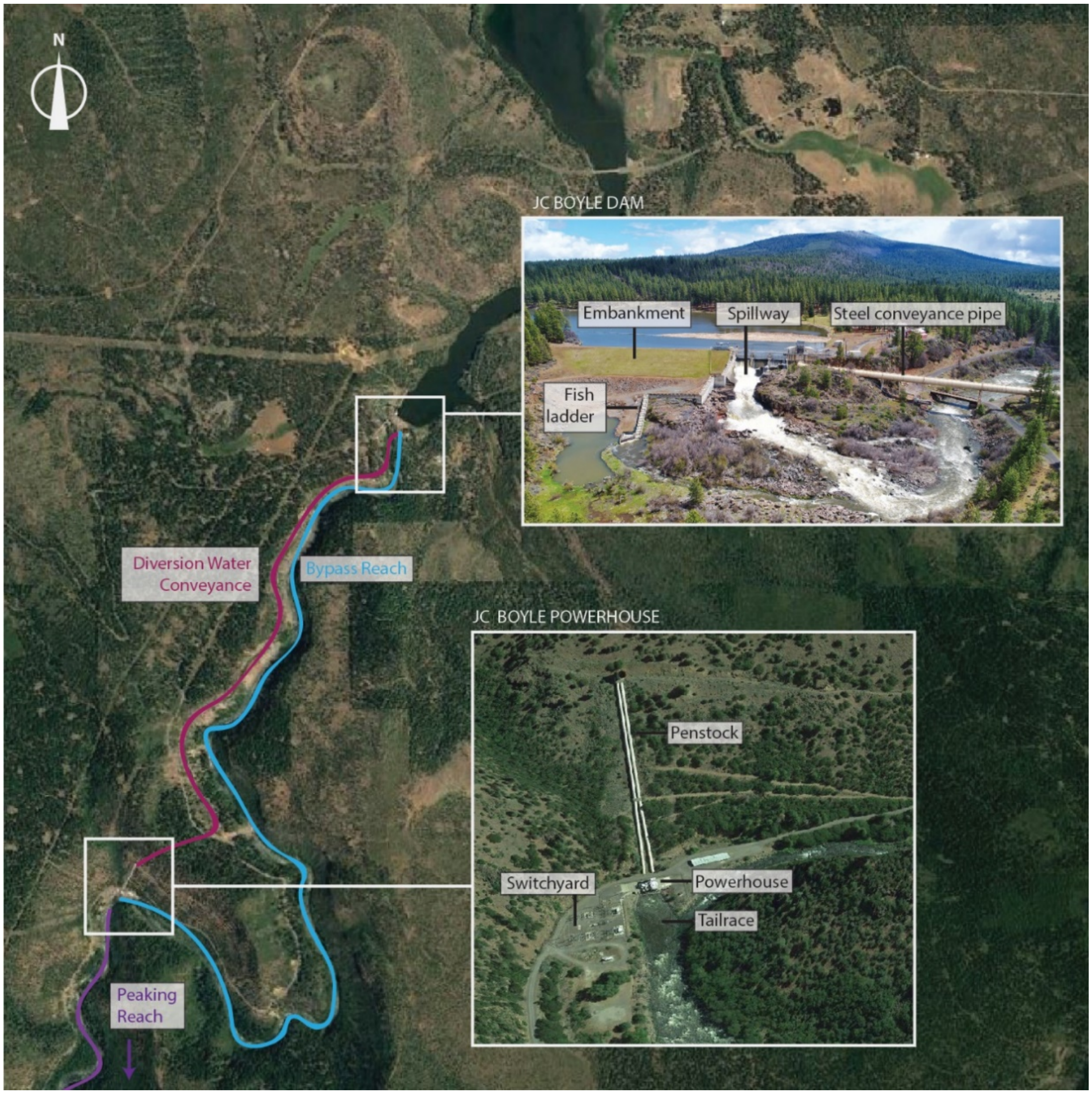

Figure 2.3-1. J.C. Boyle Dam and Associated Facilities.

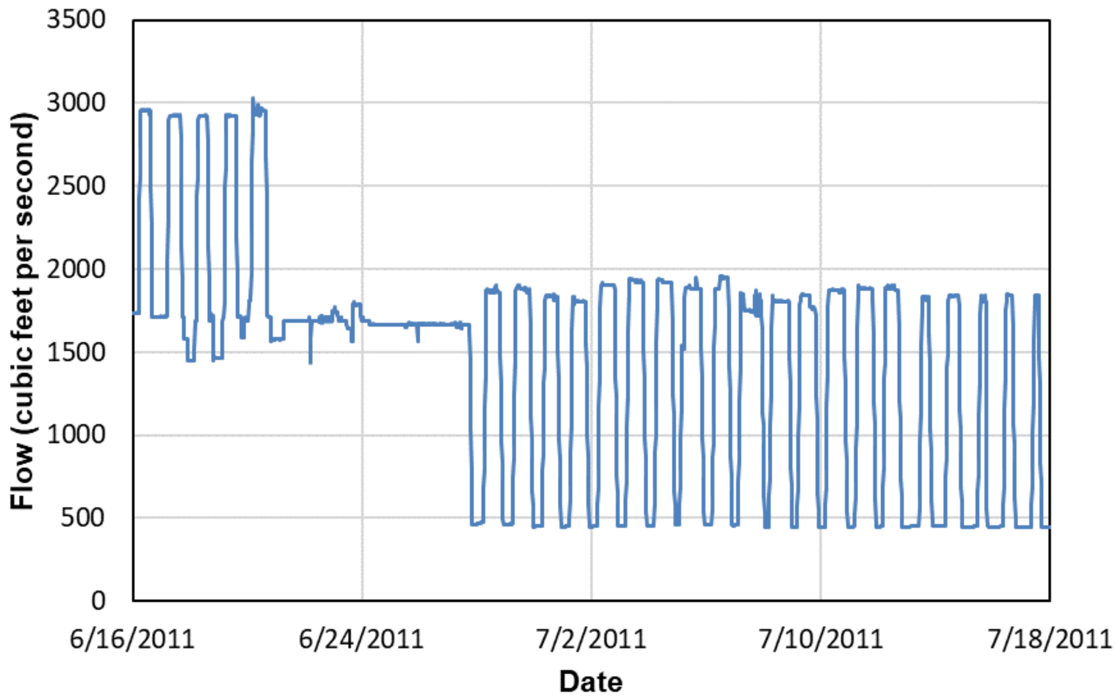

Figure 2.3-2. Example Flows in Peaking Reach downstream from J.C. Boyle Powerhouse (USGS station 11510700). Source: USGS 2011.

2.3.2 Copco No. 1 Dam and Associated Facilities

The Copco No. 1 dam and associated facilities (Figure 2.3-3) are located on the Klamath River between RM 201.8 and RM 208.3 in Siskiyou County, California. Copco No. 1 Dam was completed in 1918. The dam and associated facilities consist of the following:

1. A 33,724-acre-feet reservoir (Copco No. 1 Reservoir);
2. A 135-foot tall concrete gravity arch dam with a gated spillway (Copco No. 1 Dam);
3. A diversion tunnel capable of diverting approximately 12,000 cubic feet per second (cfs), but currently is non-operational and unable to divert any flow;
4. A switchyard with 3.03 miles of 69-kV transmission lines;
5. A water conveyance system consisting of a powerhouse intake structure, two gate houses on the right abutment, and three steel penstock pipes: one 10-foot diameter, 172-foot long, one 10-foot diameter, 194-foot long, and one 14-foot diameter, 228-foot long penstock pipes;
6. An approximately 9,800-square foot, 20-MW Copco No. 1 Powerhouse; and
7. The developed reservoir-associated recreation facilities Mallard Cove and Copco Cove. Each facility has one boat launch, one dock, and two toilets. Mallard Cove has eight picnic tables and parking for approximately 25 vehicles, while Copco Cove has two picnic tables and parking for approximately five vehicles.

There is no bypass reach for this dam.

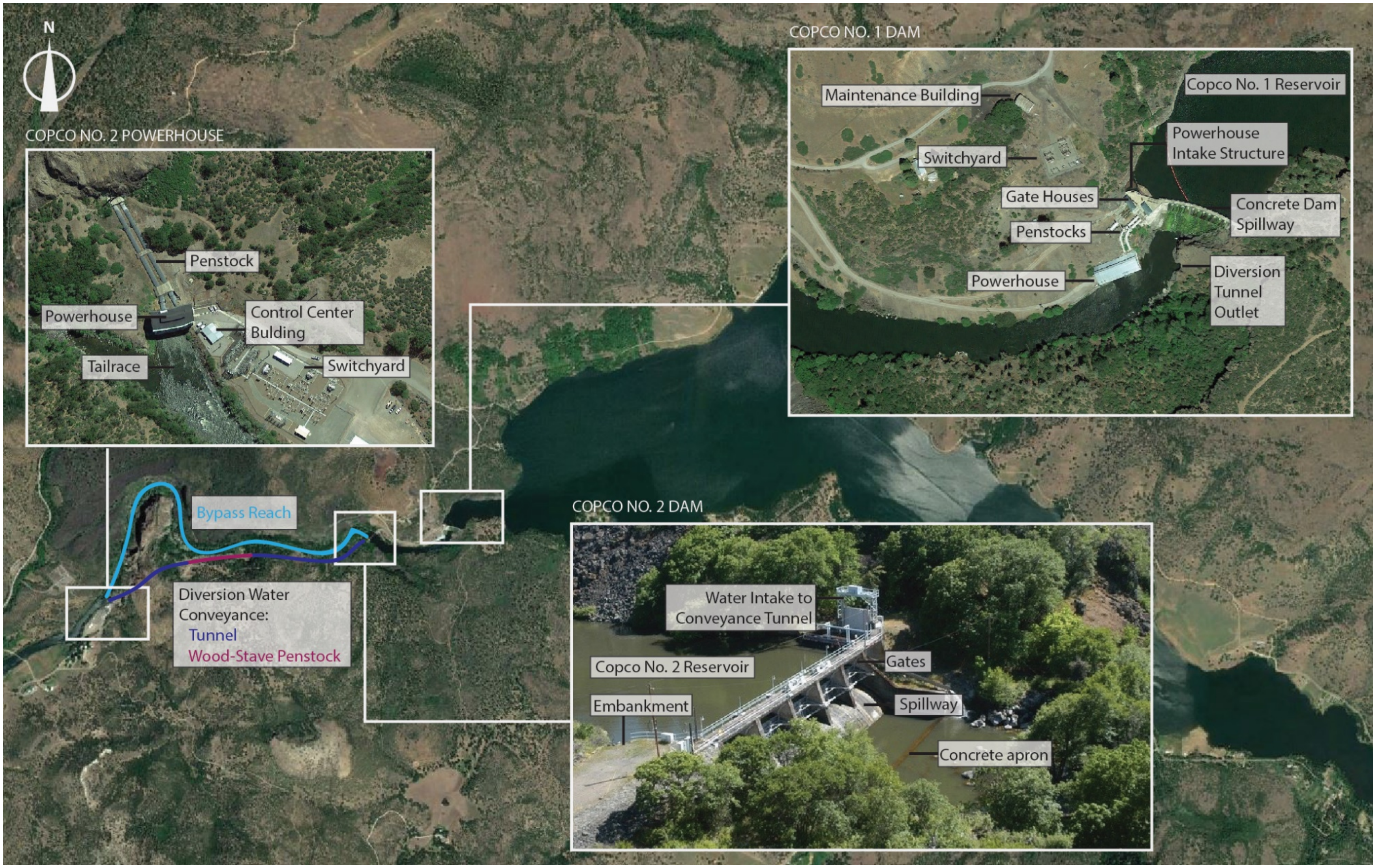

Figure 2.3-3. Copco No. 1 Dam and Copco No. 2 Dam and Associated Facilities.

2.3.3 Copco No. 2 Dam and Associated Facilities

The Copco No. 2 Dam and associated facilities (Figure 2.3-3) are located on the Klamath River between RM 201.5 and RM 201.8 in Siskiyou County, California. The Copco No. 2 Dam was completed in 1925. The dam and associated facilities consist of the following:

1. A 70-acre-feet reservoir (Copco No. 2 Reservoir);
2. A 32-foot tall concrete diversion dam (Copco No. 2 Dam) including a gated spillway, basin apron, end sill, and a remnant cofferdam upstream of the concrete dam below the normal water surface elevation of the reservoir;
3. An approximately 15,000-square foot earthen embankment section with a gunite cutoff wall along the river right sidewall;
4. A diversion water conveyance system consisting of 3,610 feet of concrete-lined, 16-foot diameter conveyance tunnel, 1,330 feet of a 16-foot diameter wooden-stave penstock, an underground surge tank, a 405.5-foot long, 16-foot diameter steel penstock, and a 410.6-foot long, 16-foot diameter steel penstock;
5. A 7,000-square foot, 27-MW Copco No. 2 Powerhouse;
6. A 1,900-square foot control center building;
7. A 4,500-square foot maintenance building;
8. A 650-square foot oil and gas storage building; and
9. The nearby mostly vacant historical Copco Village, with a total structure area of 32,200 square feet, consisting of a cookhouse, bunkhouse, storage building, bungalow, three modular houses, four old style ranch houses, and a schoolhouse/community center.

Copco No. 2 Dam is located approximately 0.25 miles downstream of Copco No. 1 Dam and has no associated recreation facilities. Water diversions for hydropower generation at Copco No. 2 Dam create a 1.5-mile-long Bypass Reach in the Klamath River between the Copco No. 2 Dam and the Copco No 2. Powerhouse (Figure 2.3-3).

2.3.4 Iron Gate Dam and Associated Facilities

The Iron Gate Dam and associated facilities (Figure 2.3-4) are located on the Klamath River between RM 193.1 and RM 200.0 in Siskiyou County, California. The Iron Gate Dam was completed in 1965. The dam and associated facilities consist of the following:

1. An approximately 50,900-acre-feet reservoir (Iron Gate Reservoir);
2. A 189-foot tall earthen embankment dam with a clay core on a basalt rock foundation and cutoff walls (Iron Gate Dam);
3. A 45-foot tall, free-standing, reinforced concrete penstock intake structure, its adjoining footbridge, and a 12-foot diameter, welded steel penstock with concrete supports;
4. The Iron Gate Fish Hatchery, which raises steelhead, coho salmon, and Chinook salmon. The hatchery includes a warehouse, a hatchery building, four fish-rearing ponds, a fish ladder, a visitor center, and four employee residences;
5. A fish trapping and holding facility including a fish ladder, holding tanks, and a processing facility at the downstream base of Iron Gate Dam;

6. A cold-water supply to Iron Gate Hatchery including an aerator, one 30-inch pipe, one 18-inch pipe, and two 24-inch pipes located below Iron Gate Dam and Powerhouse;
7. An ungated side-channel spillway capable of discharging 26,200 cfs;
8. A reinforced concrete diversion tunnel capable of diverting 2,700 cfs from the reservoir to the Klamath River and a footbridge to the gate control building;
9. A 9,000-square foot 18 MW powerhouse (excluding adjoining fish facilities);
10. 6.5 miles of 69-kV transmission lines;
11. Additional ancillary facilities, such as communication buildings, restrooms, and two residences; and
12. Recreation facilities, including the developed sites at Fall Creek, Jenny Creek, Wanaka Springs, Camp Creek, Juniper Point, Mirror Cove, Overlook Point, and Long Gulch, four small dispersed shoreline recreation sites (Iron Gate 1, 2, 3, and Long Gulch Bluff), and the recreation facilities associated with the Iron Gate Fish Hatchery. The recreation sites have a combined total of 57 picnic tables, 16 toilets, 6 boat launches, 7 docks, 1 RV dump station, and parking for approximately 200 vehicles with Camp Creek having the most facilities of all the sites. Additionally, some sites also have informal or developed campsites, a storage building, a well house, or timber shelters.

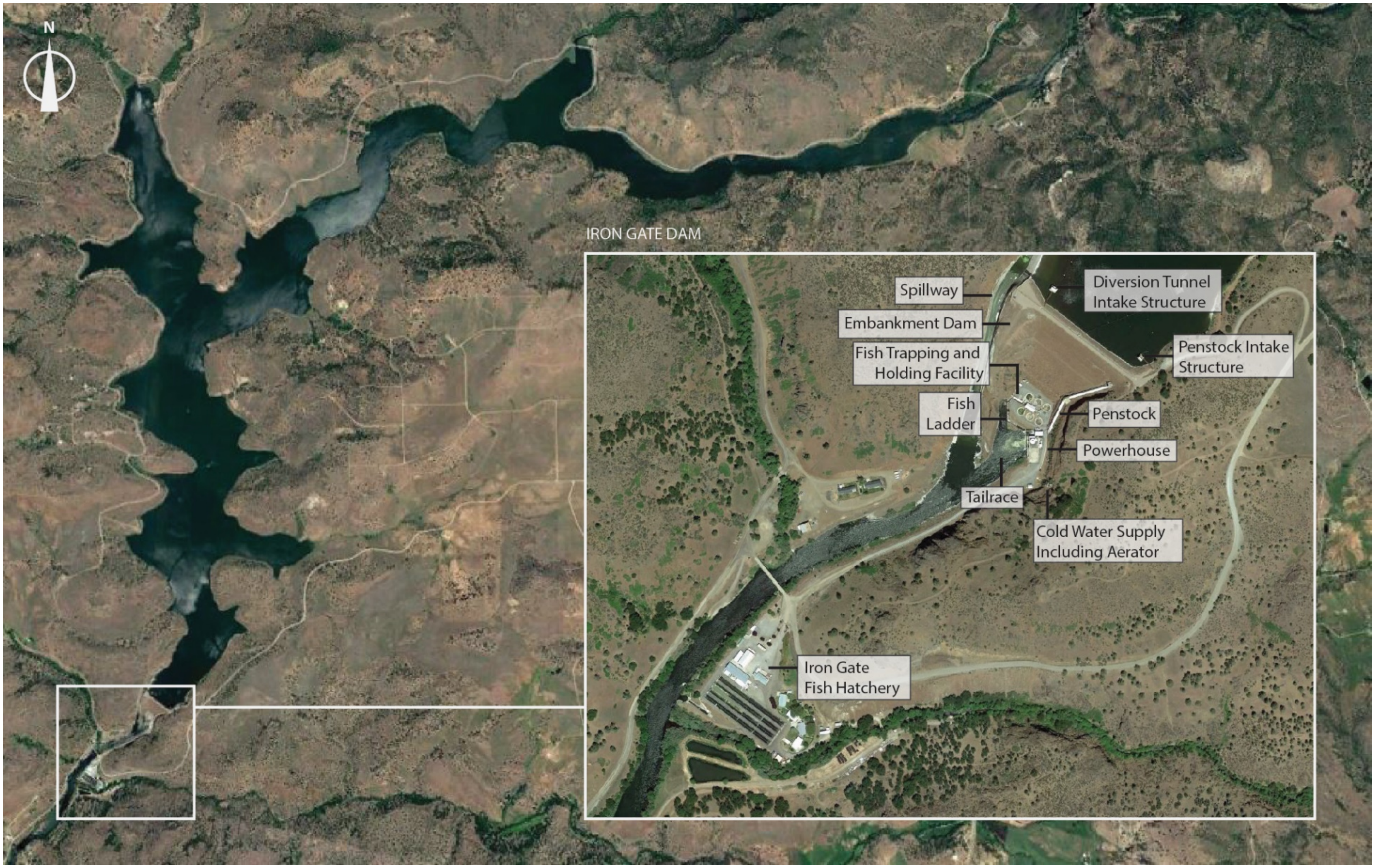

Figure 2.3-4. Iron Gate Dam and Associated Facilities.

2.4 Surrounding Land Ownership and Land Use

Land ownership within and proximal to the Project Boundary in California includes Bureau of Land Management (BLM), USDA Forest Service, State of California, PacifiCorp, and other privately-owned land (Figure 2.5-1). Further discussion of land ownership is presented in Section 3.14.2.1 *Land Ownership.*

Major Siskiyou General Plan zoning classifications surrounding the Proposed Project are Open Space – Natural Resources, Forest Resources, Agriculture – Grazing, Rural Vacant, and Rural Residential, with most of the land uses devoted to grazing and open space and conservation (Figure 2.5-2). The closest urban areas to the Proposed Project are the City of Yreka, California, and Klamath Falls, Oregon. A small amount of local land use is devoted to hydroelectric operations and recreation sites, although these activities are not specified by specific land use categories in Figure 2.5-2. There are also small residential communities and individual residences adjacent to portions of Iron Gate and Copco No. 1 reservoirs (e.g., Copco Village), and downstream.

2.5 Surrounding Land Cover

The primary land cover types within and surrounding the Proposed Project in California are Grassland/Herbaceous, Shrub/Scrub, and Evergreen Forest, along with smaller amounts of Deciduous Forest, Mixed Forest, Pasture/Hay, and Cultivated Crops (Figure 2.5-3). Developed land is generally limited to areas near existing roadways.

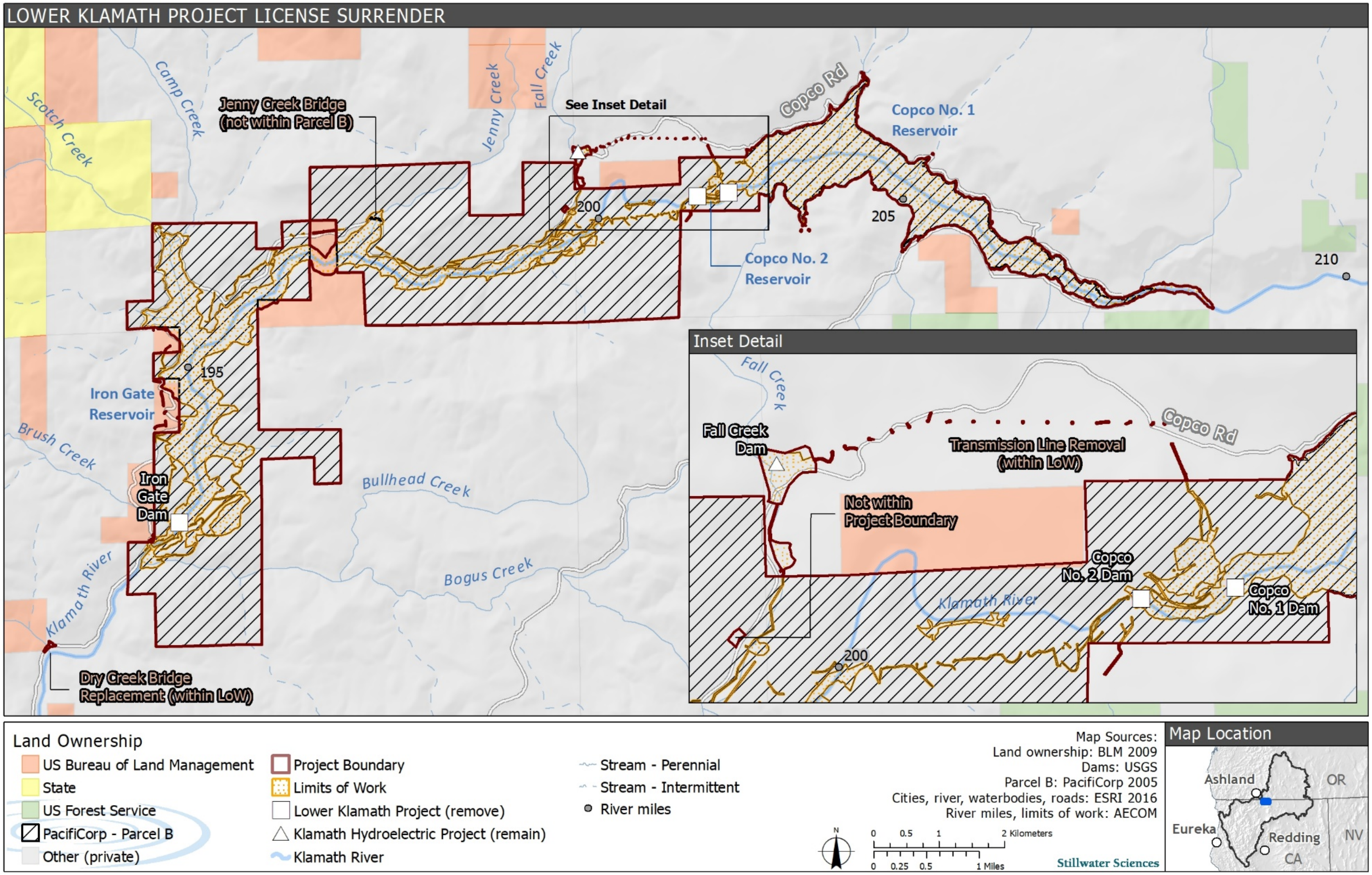

Figure 2.5-1. Surrounding Land Ownership.

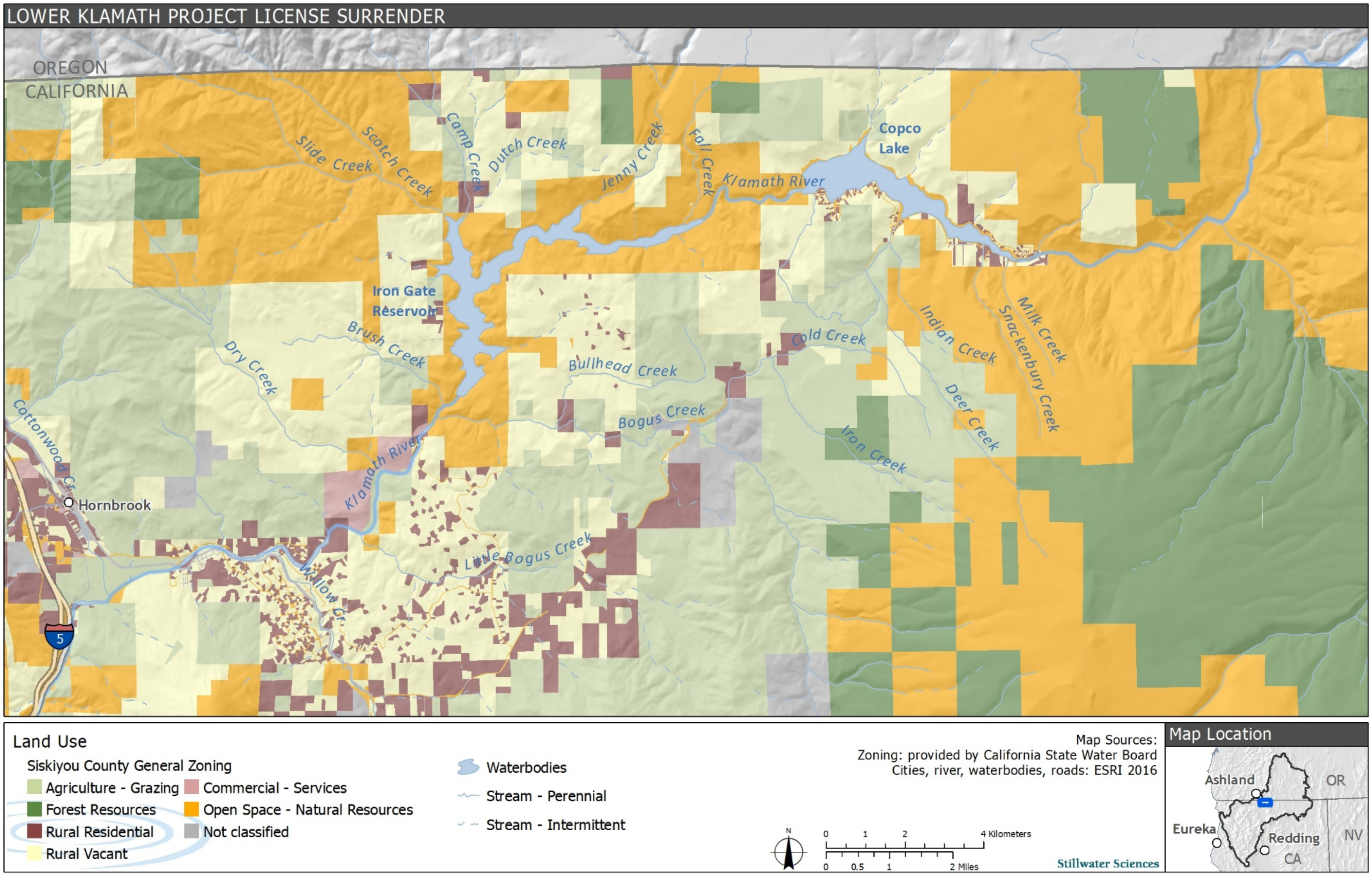

Figure 2.5-2. Surrounding Siskiyou General Plan Zoning Classifications.

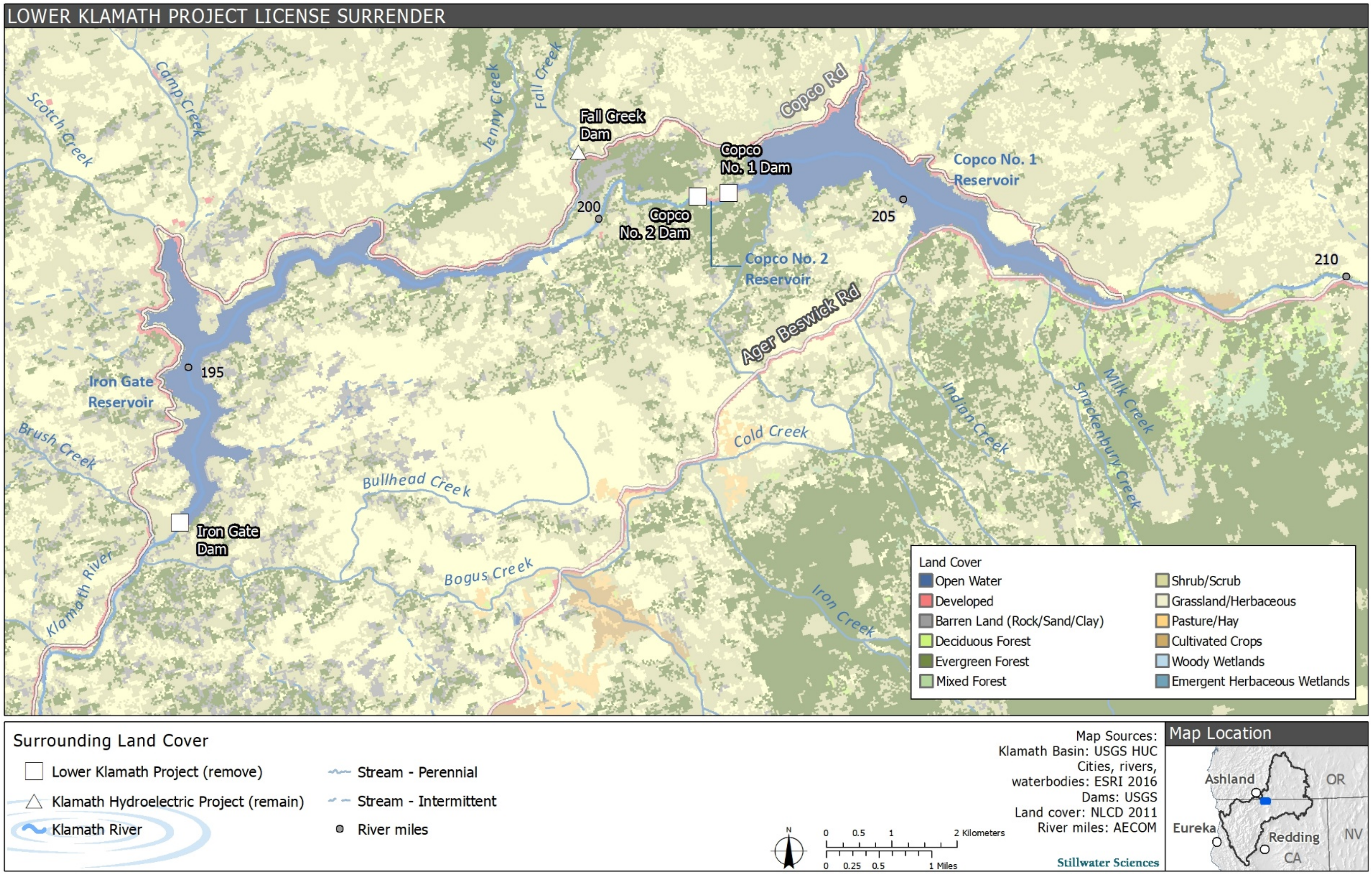

Figure 2.5-3. Surrounding Land Cover.

2.6 Project Background

2.6.1 Water Conflicts in the Klamath River Basin

Water-related disputes, including competing uses for water, water quality concerns, and impacted fisheries (commercial, tribal, and recreational) are difficult issues in the Klamath Basin. Below are some highlights of major water-related milestones and issues in the Klamath Basin over approximately the last few decades:

1957	Klamath River Basin Compact between the states of Oregon and California, ratified by the states and consented to by Act of Congress including integrated and comprehensive development of water use for equitable distribution between the two states and the Federal Government, with uses identified for domestic, irrigation, protection and enhancement of fish, wildlife and recreational resources, industrial and hydroelectric power production, and for navigation and flood prevention.
1975	Comprehensive basin plan adopted for the Klamath River in California including multiple beneficial use designations such as cold freshwater habitat, aquatic organism migration, spawning, reproduction, and/or early development for protected fish, water contact recreation, agricultural supply, and hydropower generation.
1996	Klamath River from the California/Oregon state line to Iron Gate Dam and from the confluence with the Scott River to the Klamath River Estuary added to the Clean Water Act Section 303(d) list for nutrients and temperature. Klamath River from its confluence with the Trinity River to the Klamath River Estuary added to the Clean Water Act Section 303(d) list for sediment. Klamath River from Iron Gate Dam to its confluence with the Scott River added to the Clean Water Act Section 303(d) list for organic enrichment/low dissolved oxygen.
1997	Coho salmon listed as Federally threatened under the Endangered Species Act (ESA).
1998	Lost River and shortnose sucker listed as endangered under the ESA.
1998	Klamath River from the California/Oregon state line to Iron Gate Dam and from the confluence with the Scott River to the Klamath River Estuary added to the Clean Water Act Section 303(d) list for organic enrichment/low dissolved oxygen. Klamath River from Iron Gate Dam to its confluence with the Scott River added to Clean Water Act Section 303(d) list for nutrients and temperature.
2001	(Spring) For the first time ever at a Federal reclamation (USBR) project, water deliveries from Upper Klamath Lake to Klamath Irrigation Project irrigators (and wildlife refuges) in California and Oregon did not occur in order to comply with requirements to protect ESA-listed fish (Lost River and shortnose suckers in the Upper Klamath Lake and coho salmon in the Lower Klamath River) during a severe drought (Braunworth et al. 2002).
2002	(Late summer/fall) Major fish die-off in in the Lower Klamath River of more than 33,000 adult salmon (primarily fall-run Chinook salmon) and steelhead during a disease outbreak (CDFG 2004).
2002	Coho salmon listed as threatened under the California ESA (CESA).

2003	Native American cultural use adopted as a beneficial use of the Klamath River from the Seiad Valley Hydrologic Subarea downstream to the Klamath Glen Hydrologic Subarea.
2004	First documented toxic bloom of the blue-green algae (cyanobacteria) *Microcystis aeruginosa* in Copco No. 1 Reservoir (Kann and Corum 2006).
2005	Public health warnings to avoid contact with water in Copco No. 1 and Iron Gate reservoirs due to toxic algae blooms began being posted annually.
2006	Low abundance of Klamath Basin Chinook salmon lead to severe restrictions on commercial and recreational harvest along 700 miles of the California and Oregon coast, as well as major reductions in Klamath River recreational and tribal fisheries. Broad commercial and recreational restrictions on the coast because of Klamath Basin Chinook returns were repeated in 2008, 2009, 2010, 2016, and 2017, including complete closure of commercial and recreational fisheries.
2006	Copco No. 1, Copco No. 2, and Iron Gate reservoirs identified by the USEPA for inclusion on the Clean Water Act Section 303(d) list for blue-green algae (cyanobacteria)-produced microcystin toxin as an additional cause of water quality impairment.
2010	Water deliveries from Upper Klamath Lake to Klamath Irrigation Project irrigators (and wildlife refuges) in California and Oregon significantly reduced in order to comply with requirements to protect ESA-listed suckers and provide flow augmentation for ESA-listed coho downstream of Iron Gate Dam, given dry hydrologic conditions.
2010	The Klamath Tribes limited their harvest of suckers to ceremonial use for the 25th consecutive year and experienced their 92nd year without access to salmon.
2010	Siskiyou County Advisory Election Vote on November 2, 2010 (Measure G). The Siskiyou County ballot asked, “Should the Klamath River Dams (Iron Gate, Copco 1, and Copco 2) and associated hydroelectric facilities be removed – Yes or No?” 78.84 percent of voters expressing an opinion voted “no” to dam removal, while 21.86 percent voted “yes”.
2010	Copco No. 1 Reservoir identified by the USEPA for inclusion on the California Section 303(d) List for mercury as an additional cause of water quality impairment.
2010	Klamath River from the California/Oregon state line to its confluence with the Trinity River added to the Clean Water Act Section 303(d) list for blue-green algae (cyanobacteria)-produced microcystin toxin. Iron Gate Reservoir added to the Clean Water Act Section 303(d) list for mercury.
2010	North Coast Regional Board established: (1) Site specific water quality objectives for the Klamath River; (2) an Action Plan for the Klamath River Total Maximum Daily Loads (TMDLs) addressing temperature, dissolved oxygen, nutrient, and microcystin impairments in the Klamath River; and (3) an Implementation Plan for the Klamath and Lost River Basins.
2010	USEPA approved TMDLs for the Klamath River in California.
2011	Improved abundance forecasts for Klamath River fall-run Chinook allowed for the first substantial ocean salmon fisheries off of California and Oregon to occur since 2007.
2013	NMFS and USFWS 2013 Joint Biological Opinion for the Klamath Irrigation Project, including increased minimum daily flow targets for Iron Gate Dam

	in spring and early summer months, clarifications to operations criteria for meeting requirements for minimum flows and high flows, and an adaptive management approach for minimizing fish disease.
2012–2014	In 2012, an estimated 10,000 to 15,000 migrating birds died in the Klamath Basin National Wildlife Refuge due to less water available to create wetland habitat, crowding of waterfowl during migration periods, and lethal disease outbreaks. In 2013, an estimated 9,000 migrating birds died and in 2014 an estimated 20,000 migrating birds died for the same reasons.
2012	Yurok harvest timing restrictions (Klamath River Technical Team 2013).
2013	Yurok harvest timing restrictions (Klamath River Technical Team 2014).
2016	No Yurok Tribe commercial fishery due to low returns of fall-run Chinook salmon.
2017	U.S. District Court of the Northern District of California ordered the USBR to release flushing flows from Iron Gate Dam to mitigate the effects of a parasite called *Ceratanova shasta* on outmigrating juvenile salmon and continue to implement flushing flows in future years based on specific triggers or until formal federal consultation is completed.
2017	Estimated 12,000 fall-run Chinook salmon were projected to return the Klamath River making it the smallest run on record resulting in closures of the fall-run Chinook recreational fishery and restrictions on the spring-run chinook fishery in the Klamath and Trinity rivers since record.
2017	No Yurok Tribe commercial fishery due to low returns of fall-run Chinook salmon.
2017	Karuk Tribe suspended ceremonial Chinook salmon harvest due to projected low chinook returns.

The role of the Lower Klamath Project dams in the various water quality and resource impacts listed above is part of this EIR, particularly in the description of the environmental setting for the various resource areas. As with the impacts of other facilities and actions on the Klamath River and outside the basin, the role of the dams is debated, with different stakeholders interpreting information in differing ways (see, for example, "*Fish, Farms, and the Clash of Cultures in the Klamath Basin" (*Doremus and Tarlok 2003).

2.6.2 Relationship with Klamath Hydroelectric Project

PacifiCorp currently owns and operates the Lower Klamath Project (FERC Project No. 14803) as part of the Klamath Hydroelectric Project (Klamath Hydroelectric Project) (FERC Project No. 2082). FERC exercises broad authority over most hydroelectric developments under the Federal Power Act. Among other authorities, FERC must approve and set conditions for the construction, operation, transfer of ownership and decommissioning of these hydroelectric facilities. FERC issued the original license for the Klamath Hydroelectric Project in 1956, for a term of 50 years. On March 1, 2006, the original FERC license expired. Since then, PacifiCorp has continued to operate the Klamath Hydroelectric Project (including the Lower Klamath Project complex) under annual licenses issued by FERC while PacifiCorp pursued relicensing. On June 16, 2016, at PacifiCorp's request, FERC issued an order placing the Klamath Hydroelectric Project relicensing process in abeyance.

On September 23, 2016, PacifiCorp and the KRRC filed a joint license transfer application with FERC, which seeks to transfer the J.C. Boyle, Copco No. 2, Copco No. 1, and Iron Gate dams and associated facilities to the KRRC. Concurrent with the license transfer application, the KRRC filed a license surrender application with FERC to decommission the Lower Klamath Project. The Lower Klamath Project license transfer and surrender processes are subject to FERC's approval.

2.6.3 Klamath Settlement Agreements

During the FERC relicensing process for PacifiCorp's Klamath Hydroelectric Project, a number of parties, with a range of interests including but not limited to PacifiCorp; state and federal agencies[9]; tribal governments; agriculture communities; fishery and conservation groups; local governments; and special interest groups executed several settlement agreements intended to resolve some of the problems in the Basin:

- Klamath Hydroelectric Settlement Agreement (KHSA), February 18, 2010, (later amended April 6, 2016)[10]
- Klamath Basin Restoration Agreement (KBRA), February 18, 2010
- Upper Klamath Basin Comprehensive Agreement (UKBCA), April 18, 2014
- Klamath Power and Facilities Agreement (KPFA), April 6, 2016

Among other things, the settlement agreements:

- Provided a decision-making framework and process for removal of J.C. Boyle, Copco No. 2, Copco No. 1, and Iron Gate dams and associated facilities;
- Addressed water supply and allocation issues; and
- Set forth water quality improvement and land restoration measures for the Upper Klamath Basin.

The water supply, restoration, and water quality issues all hinged on removal of the four mainstem Klamath River dams. Federal legislation was to provide much of the funding for the restoration and water supply portions of the agreements.

As originally executed, the KHSA proposed federal legislation that would have withdrawn the Klamath Hydroelectric Project from FERC's relicensing process. Instead of following the process set forth in the Federal Power Act, the original KHSA terms sought legislation to grant the Secretary of the Interior the authority to make a "Secretarial Determination" whether removing the J.C. Boyle, Copco No. 2, Copco No. 1, and Iron Gate dams and associated facilities was in the public interest and would advance salmon restoration. The agreement anticipated that the governor of each state would then be able to concur or not with the Secretarial Determination.

Federal legislation to enact the settlement agreements did not pass, and on December 31, 2015, the KBRA terminated, and on December 28, 2017 the UKBCA terminated. On April 6, 2016, some of the parties to the KHSA and KBRA executed the Klamath Power and Facilities Agreement to address the disposition of specific Oregon facilities on the Klamath River, and to commit to continue negotiations regarding certain issues addressed in the KBRA.

[9] The State Water Board is not a signatory to any of the settlement agreements.
[10] PacifiCorp is a signatory solely to the KHSA.

On April 6, 2016, the KHSA was amended to remove the need for Congressional authorization, and instead contemplate dam removal through the FERC license surrender process. The KHSA set forth the process for the signatories to form a "dam removal entity"—now the KRRC—as a non-profit organization that will, upon approval by FERC, receive ownership of the Lower Klamath Project facilities and undertake the necessary steps to remove the facilities. Pursuant to the KHSA, KRRC and PacifiCorp have initiated the FERC process, and the KRRC is now the applicant for the Proposed Project analyzed in this EIR.

2.6.4 Prior/Related Environmental Reviews

In November 2007, FERC released a final Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) for the Klamath Hydroelectric Project. The 2007 FERC EIS for the Klamath Hydroelectric Project examines the probable effects of a range of alternatives, including continued operations of the Lower Klamath Project dam complexes with or without fish passage improvements, and removal of some or all of the four dams and associated facilities that compromise the Lower Klamath Project. The 2007 FERC EIS is available online at: https://www.ferc.gov/industries/hydropower/enviro/eis/2007/11-16-07.asp

In accordance with the original KHSA, the 2012 KHSA EIS/EIR was prepared to support Klamath Hydroelectric Project dam removal and to inform the Secretarial Determination. On September 22, 2011, the United States Department of Interior (DOI) and the former California Department of Fish and Game, now California Department of Fish and Wildlife (CDFW) released the Draft 2012 KHSA EIS/EIR to analyze removal of four Klamath Hydroelectric Project dams for public comment. The agencies circulated the Final 2012 KHSA EIS/EIR, but DOI never entered a Record of Decision and CDFW never certified the document.

Similar to FERC's 2007 EIS, the 2012 KHSA EIS/EIR evaluated a range of project alternatives, including continued operation of the dams and associated facilities, with and without fish passage improvements, as well as removal of some or all of the dams that make up the Lower Klamath Project. The 2012 KHSA EIS/EIR is available online at: https://klamathrestoration.gov/Draft-EISEIR/download-draft-eis-eir.

In 2016, USBR developed the Klamath Facilities Removal EIS/EIR Supplemental Information Report (SIR) to summarize new information relevant to facilities removal of J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams (USBR 2016).

The 2012 KHSA EIS/EIR, FERC's 2007 NEPA document, and USBR's 2016 SIR provide a great deal of information regarding the existing Klamath Hydroelectric Project, the various alternatives for the future of the hydroelectric facilities, and the potential impacts of and mitigation measures for these alternatives. After careful consideration and review of past environmental documents prepared for the Klamath Hydroelectric Project, the State Water Board determined it should develop a separate EIR, rather than adopting one of the existing reviews, for the following reasons:

- The State Water Board's EIR will represent its independent judgement and analysis of the KRRC's Proposed Project.

- The KRRC's Proposed Project is different enough from the project considered in the previous environmental documents that further analysis was needed. It was clearer to address these changes as part of a comprehensive project than as supplements to existing evaluations.
- Since development of the previous environmental documents, new scientific information has been published about the Klamath River that warrants consideration. Again, it was clearer to address this new information in a manner integrated with prior information, rather than as a supplement to existing evaluations.
- The KBRA expired. The KBRA was evaluated in the 2012 KHSA EIR/EIS as a connected action to the then dam removal proposal. The KBRA is not part of the KRRC's Proposed Project.
- The State Water Board received multiple comments during the scoping phase that requested it perform additional environmental review of the Proposed Project.

2.7 Proposed Project

To meet the stated project objectives (Section 2.1), KRRC proposes to remove the Iron Gate, Copco No. 1, Copco No. 2, and J.C. Boyle dams and associated facilities. The Detailed Plan (USBR 2012a) and the Definite Plan (AECOM et al. 2018) constitute the applicant's Proposed Project. The Detailed Plan is available online at the following links:

https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/krrc_detail_1.pdf

https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/krrc_detail_2.pdf

The Definite Plan is presented in Appendix B of this EIR. To the extent that there is conflicting information in the Definite Plan relative to the Detailed Plan, the KRRC has indicated that information in the Definite Plan supersedes the information in the Detailed Plan.

A summary overview of the Proposed Project is presented in this section of the EIR, including an overall project schedule (Table 2.7-1), information regarding dam and powerhouse deconstruction activities (Section 2.7.1), and the proposed approach to reservoir drawdown (Section 2.7.2).

The Proposed Project would result in large sediment releases as water and sediment stored behind the Lower Klamath Project dams are released during, and to a lesser extent, following decommissioning activities. The Lower Klamath Project schedule proposes to minimize flood risks and downstream impacts due to the release of impounded reservoir sediments, as described in Section 2.7.3. For sediment deposits that remain in the reservoir footprint, the KRRC has proposed a set of reservoir restoration activities (Section 2.7.4), as well as restoration activities for upland areas (Section 2.7.5).

As part of the Lower Klamath Project, the KRRC proposes modifying fish hatchery facilities downstream of Iron Gate Dam on the Klamath River and upstream of Iron Gate

Dam on Fall Creek, and continuing operation of the hatcheries for eight years following dam removal, consistent with the Amended KHSA Section 7.6.6. Further discussion of hatchery operations is presented in Section 2.7.6 of this EIR. The Proposed Project also includes relocating the City of Yreka's water supply line for its Fall Creek diversions, which is described in Section 2.7.7 of this EIR. Environmental, safety, and quality of life measures associated with the Proposed Project are described in Section 2.7.8. The estimated Lower Klamath Project workforce is presented in Section 2.7.1.5 *Estimated Deconstruction Workforce and Work Shifts,* and land disposition and transfer associated with the Proposed Project is discussed in Section 2.7.10. Where greater detail regarding the Proposed Project is important to the analysis of specific environmental impacts, the additional description is presented in the relevant environmental impact section(s) of this EIR.

Table 2.7-1 provides the proposed schedule for facilities drawdown and removal along with associated Proposed Project activities before and after removal. Drawdown timing for J.C. Boyle, Copco No. 1, and Iron Gate reservoirs was selected to minimize impacts to salmonids and other aquatic species. Based on the distribution and life-history timing of aquatic species in the Klamath Basin, only a portion of fish populations are likely to be present in the mainstem Klamath River during the periods of greatest sediment transport between January and March (Figure 2.7-1). Most species are in tributaries which would be unaffected by the Proposed Project or are further downstream during this time where river conditions would be less influenced by sediment transport by the Proposed Project due to dilution by tributary inflows. Additionally, the timing of drawdown coincides with periods of naturally high suspended sediment in the Klamath River, to which aquatic species have adapted through avoidance and tolerance.

Table 2.7-1. Proposed Lower Klamath Project Schedule.

Task	Pre-dam Removal Years 1-3	Dam Removal Year 1												Dam Removal Year 2												Post-Dam Removal Year 1												Post-Dam Removal Years 2-5	Post-Dam Removal Years 6-10
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Pre-dam removal activities																																							
Seed collection, propagation, container plant material procurement	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																		
Pre-construction activities (e.g., staging area preparation)[1]		■	■	■	■	■	■	■	■	■	■	■	■																										
Invasive exotic vegetation (IEV) control	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Iron Gate Hatchery modifications including water supply replacement[2]		■	■	■	■	■	■	■	■	■	■																												
Fall Creek Hatchery modifications including water supply[2]		■	■	■	■	■	■	■	■	■	■																												
Construction access road, bridge, and culvert improvements[3]		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Recreation area facilities removal					■	■	■	■	■																														
Flood improvements					■	■	■	■																															
Yreka water supply[4]						■	■	■	■	■																													
J.C. Boyle Dam																																							
Modify canal prepare for drawdown[1]											■	■	■																										
Power generation[1]	■	■	■	■	■	■	■	■	■	■	■	■	■																										
Drawdown														■																									
Dam removal														■	■	■	■	■	■	■	■	■																	
Power generation facilties removal														■	■	■	■	■	■	■	■																		
Transmission line demolition														■	■	■																							
Copco No. 1 Dam																																							
Modify diversion tunnel, prepare for drawdown[1]							■	■	■	■	■	■	■																										
Power generation[1]	■	■	■	■	■	■	■	■	■	■	■																												
Dam modifications							■	■	■	■	■	■	■																										
Drawdown[5]												■	■	■	■	■																							
Dam removal												■	■	■	■	■	■	■	■	■	■	■	■																
Power generation facilities demolition[1,6]											■	■	■																										
Transmission line demolition[7]																			■	■																			
Copco No. 2 Dam																																							
Power generation[1]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																						
Drawdown[1,8]																		■																					
Dam removal																		■	■	■	■	■	■																
Power generation facilities demolition																		■	■	■	■	■	■																
Transmission line demolition																		■	■																				
Iron Gate Dam																																							
Power generation[1]	■	■	■	■	■	■	■	■	■	■	■	■	■																										
Dam modifications							■	■	■	■																													
Drawdown[9]														■	■	■																							
Dam removal														■	■	■	■	■	■	■	■	■	■																
Fish holding tanks and spawning building demolition[10]														■	■	■	■	■	■																				
Power generation facilities demolition																			■	■	■																		
Transmission line demolition[11]																			■																				
Restoration																																							
Fluvial sediment and habitat[12]																			■	■	■	■	■																
Revegetation activities															■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■									
Aerial pioneer crop seeding															■	■	■																						
Salvage and plant existing riparian veg															■	■	■	■	■																				
Pole cutting installation 2021															■	■	■	■																					
Pole cutting installation 2022																											■	■	■	■									
New recreation area facilities development																										░	░	░	░	░	░	░	░	░	░	░	░	░	

Dark grey shading indicates planned activities. Stippled shading represents planning for activities still under development.

[1] Definite Plan Section 8.6 Construction Schedule does not explicitly list these tasks. Timing for these tasks provided in KRRC (2018).
[2] While the specific timeline is not proposed, Iron Gate Hatchery and Fall Creek Hatchery must be operational prior to reservoir drawdown.
[3] Definite Plan - Section 8.6 Construction Schedule does not explicitly list all of the proposed road access improvement items, however they would occur before, during, and after dam removal, as needed.
[4] Proposed pipeline relocation would have to occur before Iron Gate Dam removal. The KRRC proposes that the outage associated with the final connections would preferably occur during the winter to avoid disruption to Yreka's water supply.
[5] Scheduled from November 3 to March 8.
[6] Scheduled from September 30 to December 7.
[7] Scheduled from June 18 to July 30.
[8] Copco No. 2 Dam drawdown will occur on one day (May 1, 2021)
[9] Scheduled from January 1 to March 2.
[10] Scheduled from January 4 to June 7.
[11] Scheduled for one week from June 1 to June 7.
[12] Refers to movement of additional sediment in the reservoir footprints to provide tributary connectivity and create wetlands, floodplain and off-channel habitat features. Also includes placement of large woody debris (LWD) features.

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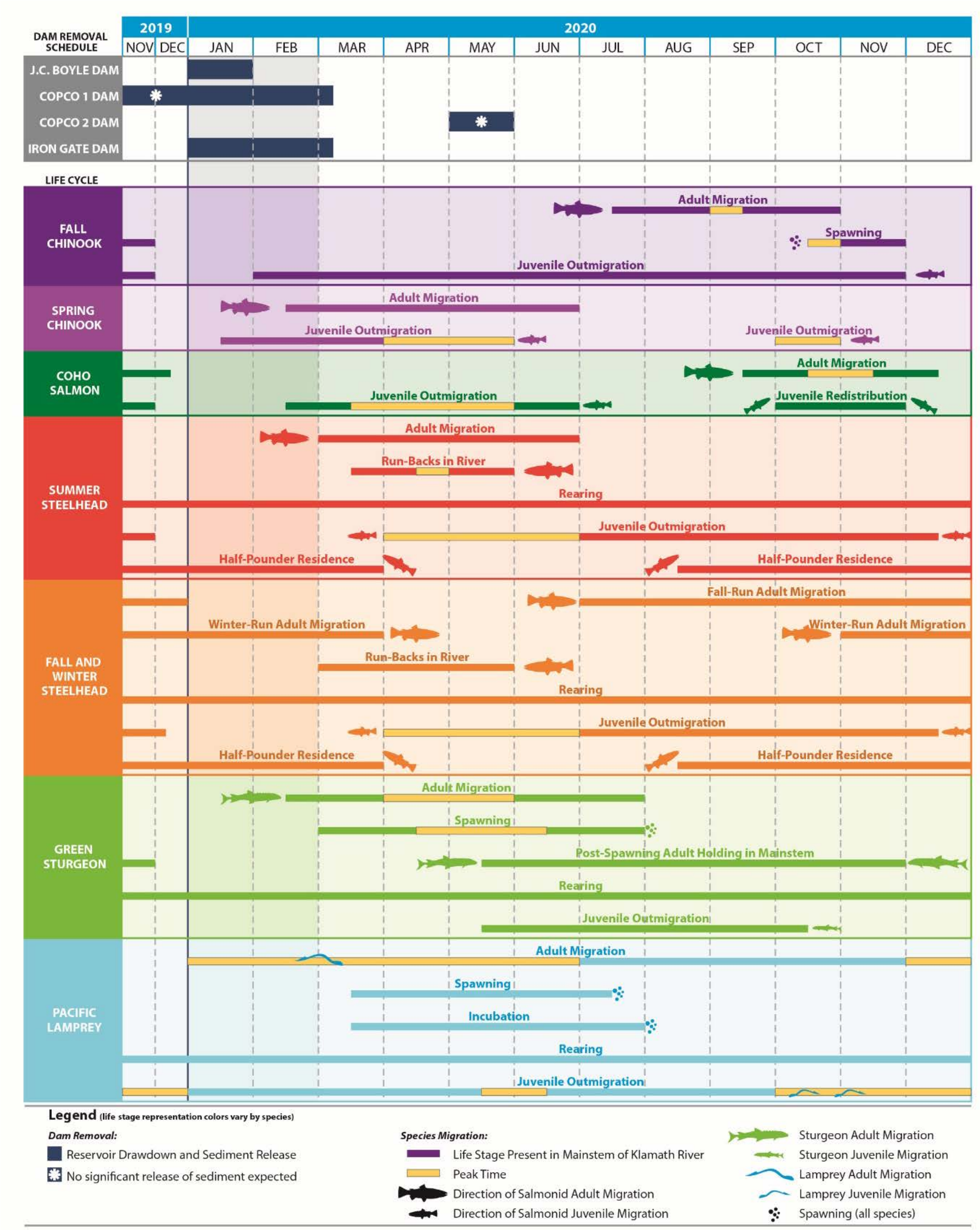

Figure 2.7-1. Distribution and Life-History Timing of Aquatic Species in the Klamath Basin. Source: CDM Smith.

2.7.1 Dam and Powerhouse Deconstruction

2.7.1.1 J.C. Boyle Dam and Powerhouse

The KRRC proposes removal of the J.C. Boyle dam, spillway and gates, powerhouse, powerhouse equipment, and concrete fish ladder. The applicant further proposes removal of ancillary facilities, such as the canal and pipeline that convey water to the powerhouse. The complete removal of the embankment section and concrete cutoff wall to the bedrock foundation are proposed to ensure long-term stability of the site and to prevent the development of a potential fish barrier in the future. In order to access the dam for deconstruction, the KRRC would perform a controlled reservoir drawdown using the spillway gates, conveyance pipeline and canal, and diversion conduit. J.C. Boyle Dam and Powerhouse features to be removed and removal plans are detailed in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*.

2.7.1.2 Copco No. 1 Dam and Powerhouse

Deconstruction Activities

Features to be removed for Copco No. 1 Dam and Powerhouse are summarized in Table 2.7-2. An overview of the facilities and removal plans is found below. Additional details are presented in Appendix B: *Definite Plan*.

The Detailed Plan (USBR 2012a) included sequential notching of Copco No. 1 Dam as part of reservoir drawdown and dam deconstruction, where the notching option would have included making releases through a combination of modifications to the existing diversion tunnel to restore operation through three existing 6-foot-diameter pipes in the diversion tunnel intake structure, in addition to a series of 13 notches sequentially excavated in the left abutment of the dam. Successful reservoir drawdown using the notching option would be highly dependent on successful dam demolition and notching during January and February, with the following identified constructability and schedule risks: safety of construction workers operating on narrow, steep access roads during winter months with wet and icy conditions; weather delays that are likely to be worse in the wettest years when reservoir drawdown would rely on notching more than in dry years; and incomplete reservoir drawdown during wet years if notching is not complete. Due to these risks, KRRC is no longer proposing notching as the preferred plan for demolition of this dam (Appendix B: *Definite Plan*).

Instead, as a necessary first step for removal of Copco No. 1 Dam, the KRRC's Proposed Project would install a new, larger (14- by 16-foot) roller gate on the downstream end of the existing diversion tunnel, to be used as the primary mechanism for reservoir drawdown. Modifications to the diversion tunnel would begin by June of the year prior to reservoir drawdown (Table 2.7-1). The KRRC then proposes the complete removal of the concrete gravity arch dam between the left abutment rock contact and the concrete powerhouse intake structure on the right abutment (Figure 2.7-2, 1 of 4) to ensure long-term stability of the site. So that river bed sediment mobilization through natural channel processes does not expose the concrete foundation of the dam and create a fish passage barrier or prevent bedload movement in the active bed layer, removal of Copco No. 1 Dam would occur to 20 feet below the pre-dam streambed at the dam, or to the approximate elevation of 2,463.5 feet (Appendix B: *Definite Plan*).

The KRRC's Proposed Project indicates dam demolition would occur over approximately four months using blasting, hydraulic excavators, conventional or diamond-wire sawcutting, and drilling to remove the dam in sections from the top of the dam to 20 feet below the streambed level at the dam. After May 15 of dam removal year 2 (Table 2.7-1), conventional drilling and blasting methods would remove the dam in horizontal sections (lifts) with each section estimated to be approximately 12 feet high. Drilling would likely require the most time during the demolition and control the overall rate of dam removal so drill crews would work two 10-hour shifts, 5 days per week. Blasting is estimated to occur an average of between three and six shots per day for up to 16 weeks. Concrete rubble from the dam removal would be dropped to the base of the dam to form a temporary access road between the dam base, the powerhouse, and the powerhouse intake structure, then hauled by truck to the disposal site on the right abutment. The temporary access road would be removed once it is no longer necessary.

Table 2.7-2. Copco No. 1 Dam and Powerhouse Decommissioning and Removal Proposal.

Feature[1]	KRRC Proposal
Concrete Dam	Remove to elevation 2,463.5 feet, which is 20 feet below original river channel bottom
Spillway Gates and Operators, Deck, Piers	Remove
Penstocks	Remove
Powerhouse Intake Structure	Remove
Gate Houses on Right Abutment	Remove
Diversion Control Structure	Remove[2]
Tunnel Portals[3]	Retain the tunnel, plug the tunnel portals with reinforced concrete
Powerhouse (including mechanical and electrical equipment)	Remove
Powerhouse Hazardous Materials (transformers, batteries, insulation)	Remove
Four 69-kv Transmission Lines (3.03 miles total) (including poles and transformers)	Remove
Switchyard	Remove
Warehouse and Residence[4]	Remove

[1] Feature as presented in Appendix B: *Definite Plan – Table 5.3-1*.
[2] The existing diversion control structure includes gate hoists, stems, and wire ropes, which would be demolished along with unstable concrete as part of modifying the diversion structure prior to reservoir drawdown. Proposed features to modify the diversion control structure (i.e., new downstream tunnel gate and portal, new upstream blind flanges) would be removed as part of reservoir drawdown and dam deconstruction.
[3] Refers to the Diversion Tunnel shown in Figure 2.7-2.
[4] Refers to the Maintenance Building and the North and South Residences shown in Figure 2.7-2.

The spillway components would be removed as the reservoir is drawn down to below the spillway crest (to be completed by January 1 of dam removal year 2). Once the reservoir is drawn down to an approximate elevation of 2,590 feet, a barge-mounted crane would be used to remove spillway gates and operators, the spillway bridge deck, and the spillway gate piers in the dry. The barge-mounted crane would then be removed from the site.

The KRRC proposes that the powerhouse removal would occur as the reservoir is drawn down through the new large gate structure at the downstream end of the diversion tunnel. Gate houses and penstocks would be demolished, and mechanical and electrical equipment would be removed from the powerhouse. The above grade portion of the powerhouse would be demolished and prepared for use as a part of a temporary construction access road between the dam base, the powerhouse, and the powerhouse intake structure. The KRRC proposes to construct and maintain temporary cofferdams in the river channel and to use sump pumps as required to enable dewatered conditions during the removal of the remaining powerhouse portions, the diversion control structure, and concrete in the powerhouse intake structure on the right abutment. The cofferdams would be supported using re-purposed on-site concrete rubble from Copco No. 1 Dam, plus as-needed source material from an existing borrow site located on the hillslope above Copco No. 1 village, where the borrow site was used during dam construction. Sump pumps and cofferdams would be removed from the river channel when they are no longer needed.

The KRRC proposes to plug the upstream diversion tunnel intake, then demolish the new diversion gate structure and plug the downstream portal of the diversion tunnel with concrete.

Site demobilization would occur after the dam site, staging areas, and concrete disposal site are restored, including topsoil and seed placement, where required as explained in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)* and the KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*).

Construction Access and Road Improvements

An overview of construction access roads required for removal of Copco No.1 Dam and Powerhouse, and associated work, are shown in Figure 2.7-2. Existing conditions of the highways, local roads, and structures to be used were observed in the field to identify deficiencies and determine if improvements are necessary for mobilization and/or hauling during construction and demolition activities. The Proposed Project in the KRRC's Definite Plan *(*Appendix B: *Definite Plan*) details the below road, bridge, and culvert improvements to facilitate access for dam removal vehicles and equipment, to ensure safety for public and project road users during dam deconstruction activities, and to return roads used by the Proposed Project related vehicles in an acceptable state, mitigating any potential reduction in function attributed to the dam removal work. For additional details, see Appendix B: *Definite Plan − Table 7.4.1, Sections 5.2.2, 5.3.2, 5.4.2* and *5.5.2*, and *Appendix K*.

Road and Bridge Improvements/Replacements

- Copco Road from I-5 to Ager Road—some pavement rehabilitation
- Copco Road from Ager Road to Lakeview Road—poor condition, some pavement rehabilitation
- Copco Road Bridge—potential erosion protection to abutments/ pier
- Dry Creek Bridge—to be replaced, strengthened, or provided with a temporary crossing
- Copco Road between Lakeview Road and Daggett Road—poor condition, some pavement rehabilitation
- Jenny Creek Bridge—to be replaced post-construction
- Copco Road from Daggett Road to Copco Access Road—some road surface rehabilitation during construction

- Fall Creek Bridge—to be replaced
- Copco Access Road—grading and clearing required
- Barge Access to Copco Lake—minor access improvements for barge/crane, boat ramp extension
- Ager Beswick Road—minor access improvements for barge/crane, boat ramp extension at Mallard Cove
- Daggett Road—some road surface rehabilitation during construction
- Daggett Road Bridge—to be replaced, strengthened or provided with a temporary crossing.
- Lakeview Road Between Copco Road and Disposal Site—some road surface rehabilitation during construction
- Lakeview Road Bridge—to be replaced, strengthened or provided with a temporary crossing.
- Powerhouse Access Road—some road surface rehabilitation during construction
- Upstream Left Abutment Access Road—to be re-established then reclaimed post-construction
- Access Road from Long Gulch Recreational Facility to Lakeview Road—some road surface rehabilitation during construction.
- Access Road from Overlook Point Recreational Facility to Copco Road—some road surface rehabilitation during construction.

Culvert Replacements

- Copco Road at Beaver Creek, East Fork Beaver Creek, Raymond Gulch, West Fork Unnamed Creek, Scotch Creek, 200 feet east of Scotch Creek, small cross-culverts between Brush Creek and Scotch Creek, Camp Creek
- Patricia Avenue at East and West Forks Unnamed Creek
- Deer Creek
- Indian Creek
- Daggett Road at Fall Creek

For Copco No. 1 specifically, three roads would have pavement or road surface rehabilitation as necessary during or post-construction, temporary traffic controls during road improvements, and construction signage; two bridges would be replaced; one road would be regraded and cleared; and two boat ramps would be extended. The delivery of off-road construction equipment, including cranes, large excavators, loaders, and large capacity dump trucks would be by special tractor-trailer vehicles operating under "wide load" restrictions and at appropriate speeds.

Staging Areas and Disposal Sites

Construction staging areas and a disposal site for removal of Copco No.1 Dam and Powerhouse are shown within the Limits of Work in Figure 2.7-2. The contractor would need to mobilize construction equipment to the site by approximately June of the year prior to drawdown to prepare the staging areas and disposal site and construct the diversion tunnel improvements.

The primary 2.3-acre staging area for the Copco No. 1 Dam complex would be located on the right abutment near the existing Copco No. 1 switchyard (Figure 2.7-2, tile 1 of 4). Two smaller staging areas are in the near vicinity (0.6 acre across the road and 0.5 acre near the penstocks) (Figure 2.7-2, tile 1 of 4).

A single 3.5-acre disposal site, located on the right abutment at the current location of a maintenance building and the vacant south residence (Figure 2.7-2, tile 1 of 4), would be used for concrete debris generated from the removal of the dam and powerhouse as detailed in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*. The disposal site would be graded as a hill (maximum fill height of about 55 feet) contoured to blend into the surrounding topography. Preparation of the disposal area would include clearing of vegetation, demolition of the two structures, removal of transmission lines, and stripping and stockpiling of excavated topsoil for later use. After placement of the concrete debris (without rail and rebar), the on-site disposal area would be covered with topsoil and the excavated embankment material from Copco No. 2 Dam (see Section 2.7.1.3 *Copco No. 2 Dam and Powerhouse*), graded, sloped for drainage, and hydroseeded. Compaction of materials placed in the disposal area other than by bulldozers spreading the materials and equipment travel would not be required.

Erosion monitoring would be completed on an annual basis for five years following placement to assess whether significant erosion and slope deterioration has occurred. If significant erosion occurs, the eroded area shall be repaired.

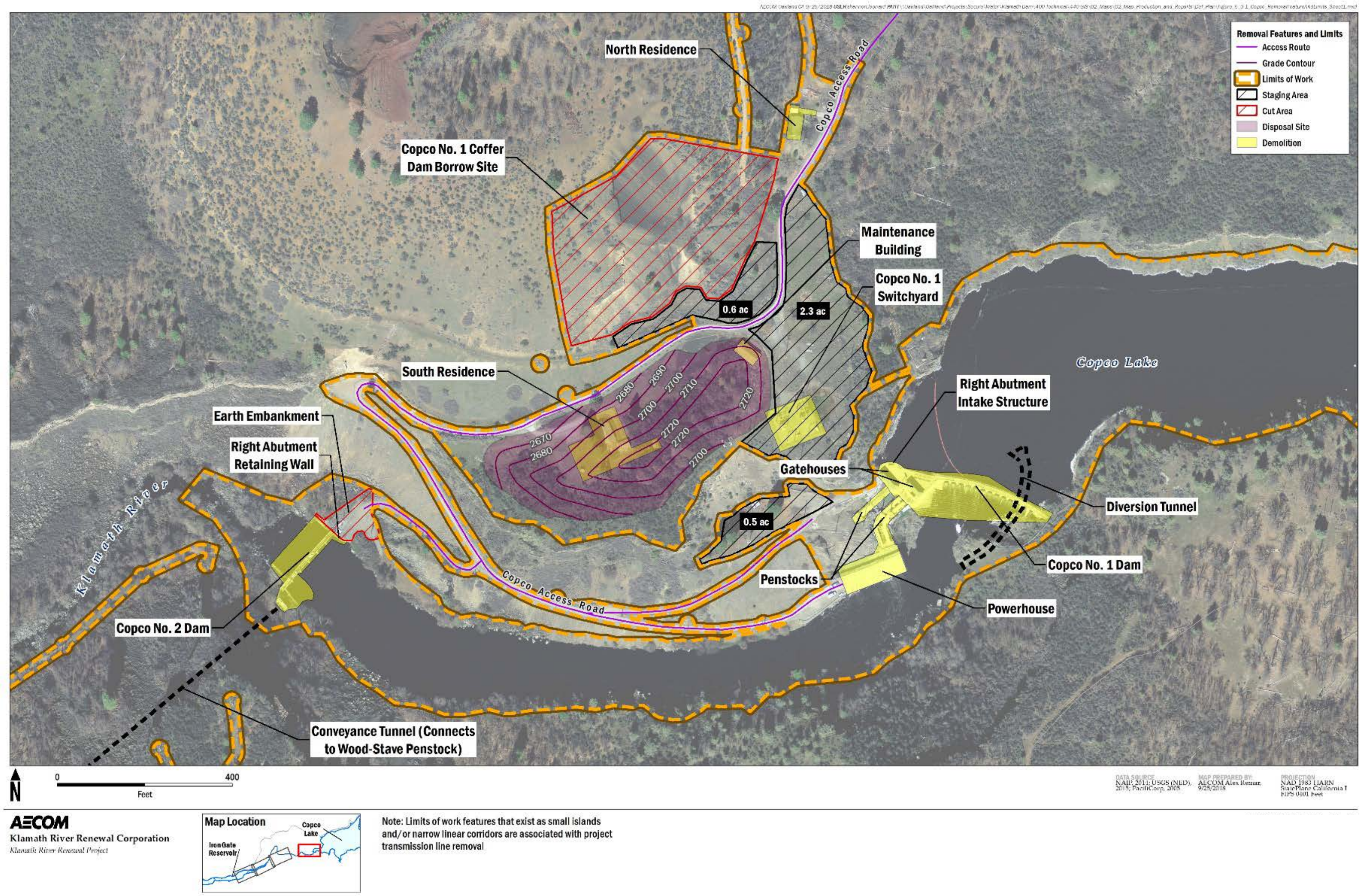

Figure 2.7-2. Copco No. 1 and Copco No. 2 Dam Removal Features and Limits of Work (1 of 4).

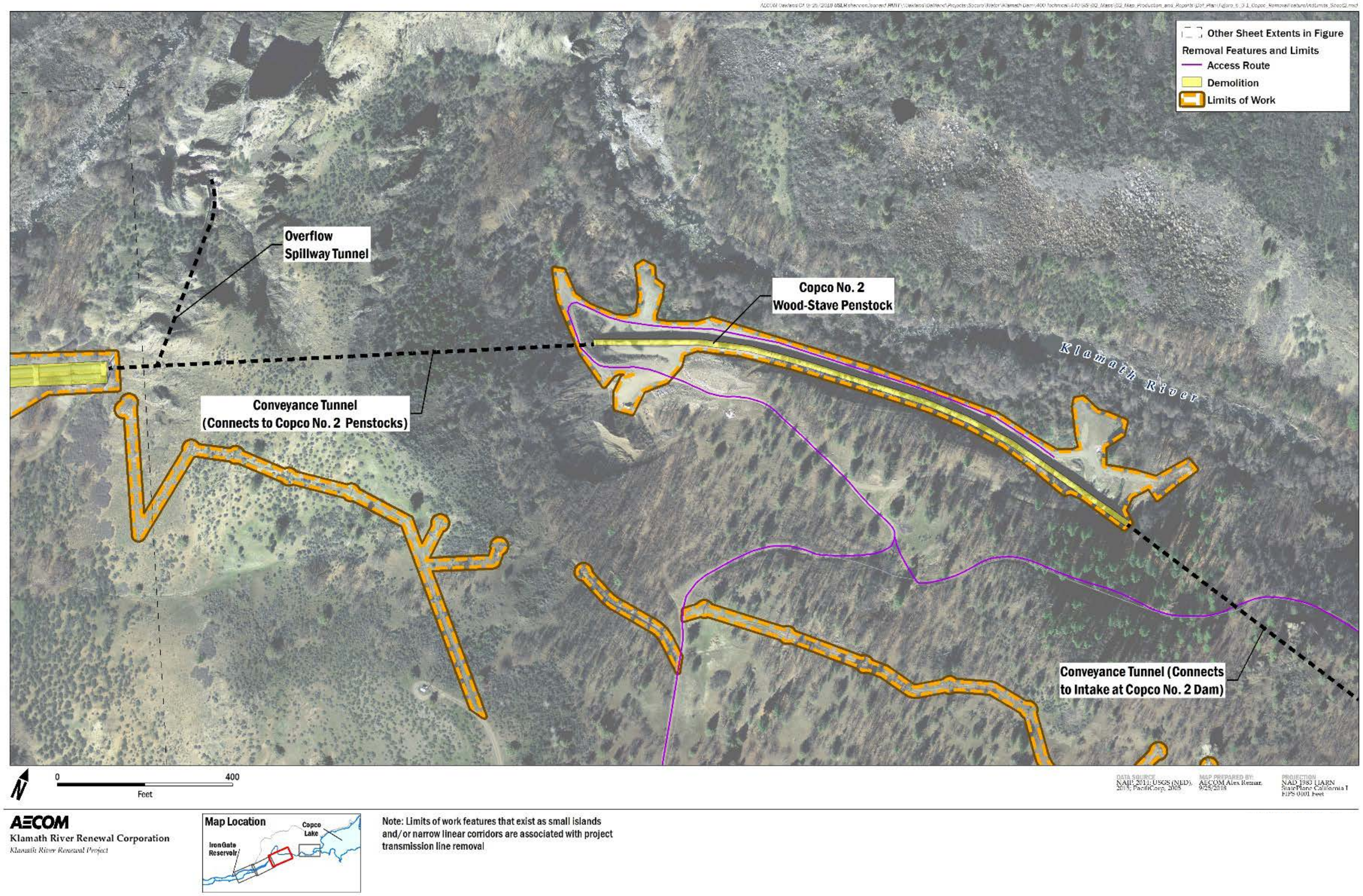

Figure 2.7-2. Copco No. 1 and Copco No. 2 Dam Removal Features and Limits (2 of 4).

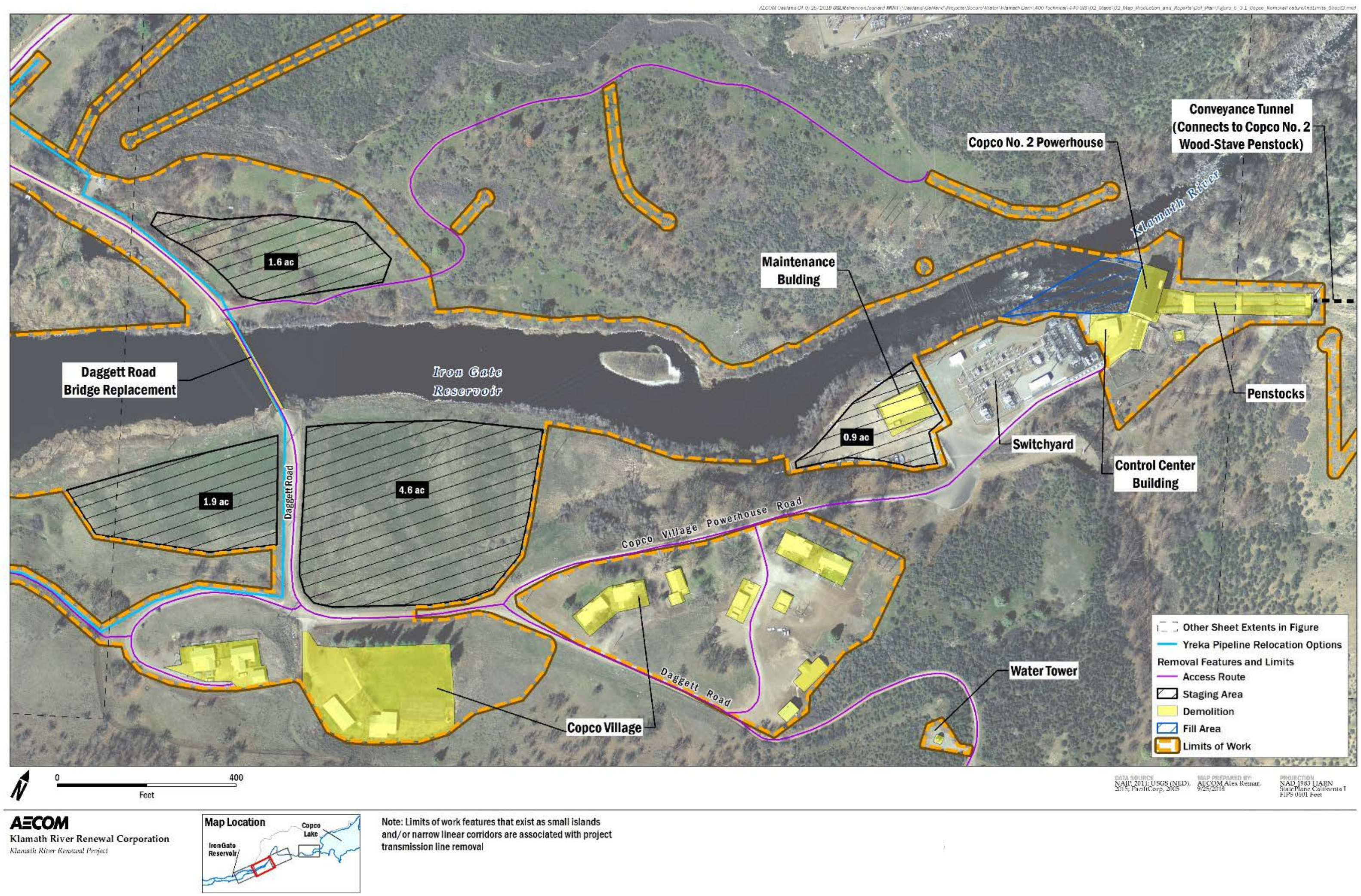

Figure 2.7-2. Copco No. 1 and Copco No. 2 Dam Removal Features and Limits of Work (3 of 4).

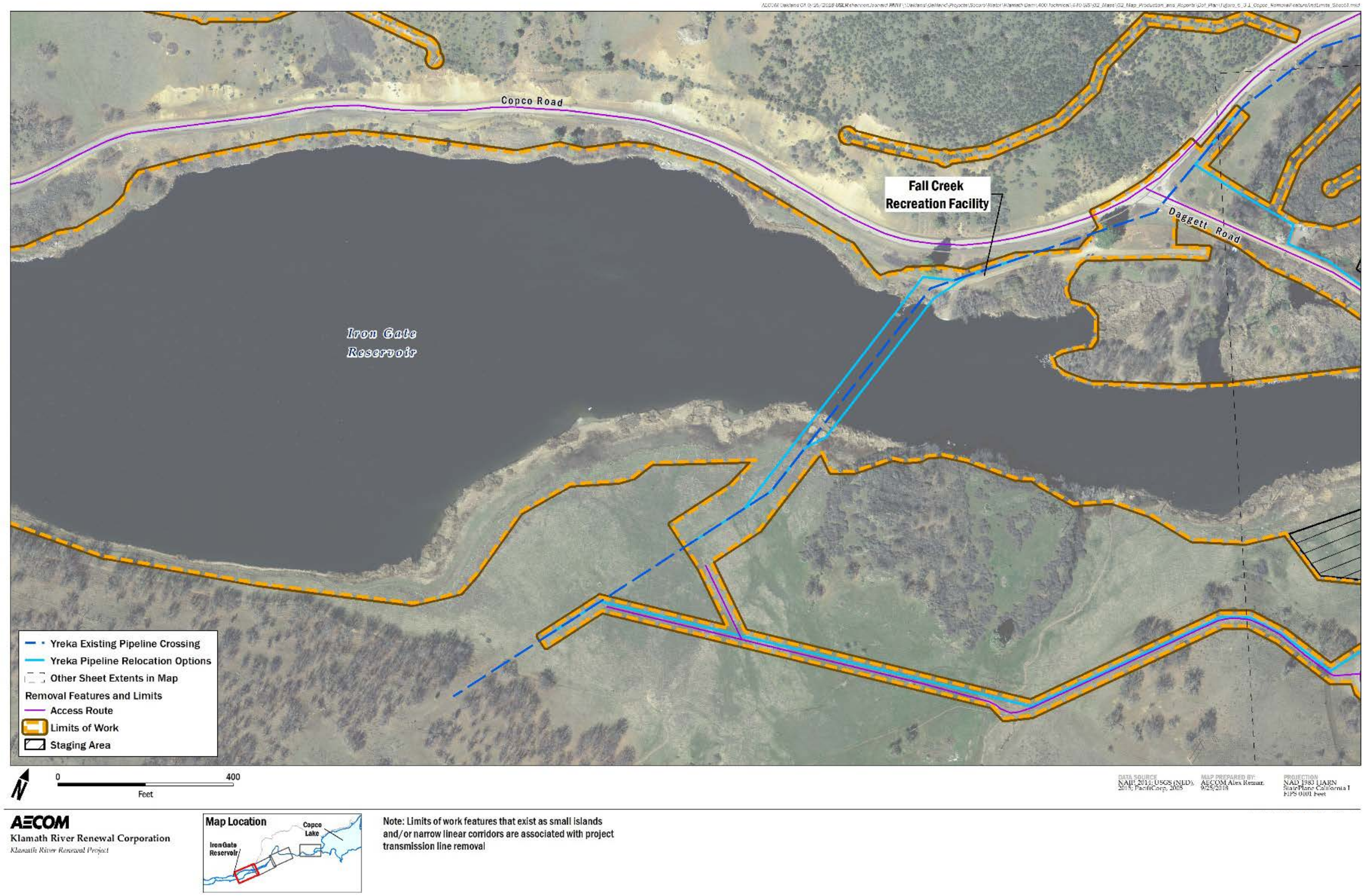

Figure 2.7-2. Copco No. 1 and Copco No. 2 Dam Removal Features and Limits of Work (4 of 4).

Imported Materials and Waste Disposal

The most likely import materials for supporting dam removal include gravel surfacing from a commercial quarry for temporary haul roads, sheetpile or H-piles for construction of cofferdams (in addition to the concrete rubble and borrow pit materials described above), topsoil, seed and mulch materials, and minor quantities of ready-mix concrete and reinforcing steel from local commercial sources for tunnel plugs. Additional imported materials would be necessary for culverts, pavement or road surface improvements, signage, and bridge replacements. Construction of the new gate structure for Copco No. 1 in dam removal year 1 would require importing mechanical equipment, additional reinforcing steel, and potentially ready-mix concrete for lining the diversion tunnel, if inspections determine it is necessary.

Estimated quantities of materials generated during removal of Copco No. 1 Dam and Powerhouse, numbers of truck trips, and approximate haul distances for waste disposal in miles per round trip (miles RT) are detailed in Table 2.7-3 based on the information itemized in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 7 Road Improvements)* and updated by KRRC based on further investigations since the release of the Definite Plan (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., November 2018). Excavated concrete would be placed in the on-site disposal site described above. Rail and reinforcing steel would be separated from the concrete prior to placement in the disposal area and hauled to a local recycling facility. All mechanical and electrical equipment would be hauled to a suitable commercial landfill or salvage collection point (e.g., Yreka Transfer Station, Yreka, CA). The estimated haul distances for waste disposal not on-site assumed the Yreka Transfer Station in Yreka, CA. The Yreka Transfer Station is a Class III sanitary landfill with a remaining capacity of approximately 3,924,000 yd^3 (2010) that accepts construction, demolition, and mixed municipal waste and a medium volume transfer station accepting metals and mixed municipal recyclable materials.

Table 2.7-3. Estimated quantities of waste disposal for full removal of Copco No. 1 Dam.

Waste Material	In-Situ Quantity	Bulk Quantity[1]	Disposal Site[2]	Peak Daily Trips[3]	Total Trips[4]
Concrete	75,900 yd^3	104,00 yd^3	On-site	2 units/50 trips (unpaved road)	4,430 trips (2 miles RT)
Rebar	1,100 tons	--	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	110 trips (62 miles RT)
Mech. and Elec.	1,100 tons	--	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	140 trips (62 miles RT)
Building Waste	7 buildings; 7,500 ft^2	1,700 yd^3	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	90 trips (62 miles RT)
Power Lines	4.3 miles of 69-kV and smaller	--	Transfer station near Yreka, CA	--	5 trips (62 miles RT)
Wood Utility Poles	120 poles	--	Transfer station near Yreka, CA	--	8 trips (62 miles RT)

Source: S. Leonard, AECOM as KRRC Technical Representative, pers. comm., November 2018

1 Volumes increased 30 percent for concrete rubble from reinforced concrete and 40 percent for concrete rubble from mass concrete.

2 Currently, solid waste is transferred approximately 45 miles from the Yreka Transfer Facility to the Dry Creek Landfill facility near White City Oregon.

3 Peak daily trips for each site are based on the number of vehicles (units) shown, operating within one 8-hour shift.

4 Total trips of concrete assume off-highway articulated trucks with a nominal load capacity of 22 yd^3. Total trips for hauling rebar using truck tractor-trailers is based on 10 tons per trip. Total trips for hauling mechanical and electrical items using truck tractor-trailers is based on 8 tons per trip. Total trips for building waste using truck tractor-trailers is based on 10 yd^3 per trip. Mileage is reported in miles per round trip (miles RT).

Potential hazardous materials at Copco No. 1 Dam and Powerhouse include asbestos, batteries, bearing and hydraulic control system oils, treated wood, flammable gases, nonflammable gases, flammable and combustible liquids, mercury in older light switches, contaminated soils near painted exterior equipment, and coatings containing heavy metals in the powerhouse, on the exterior surfaces of the steel penstocks, air vents, and other painted materials. All hazardous materials would be handled and disposed of as hazardous waste at an approved hazardous waste facility in accordance with applicable federal and state regulations. Additional details and their disposal are provided in the KRRC's Hazardous Material Management Plan (Appendix B: *Definite Plan – Appendix O3*) and discussed in Section 3.21 *Hazards and Hazardous Materials* of this EIR.

2.7.1.3 Copco No. 2 Dam and Powerhouse

Deconstruction Activities

The KRRC's Proposed Project would remove the Copco No. 2 Dam, the unnamed reservoir associated with the Copco No. 2 Dam (hereinafter referred to as Copco No. 2 Reservoir), the Copco No. 2 Powerhouse, and their associated structures and equipment (Table 2.7-4). Additional details are presented in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*. The KRRC proposes to remove the Copco No. 2 dam, the associated structures, and drain the reservoir in dam removal year 2 by lowering the reservoir water surface elevation, constructing temporary cofferdams to dry out sections of the construction area, removing the structures in sections under dry conditions, and restoring the dam site after the structures are removed.

The KRRC proposes to begin preparing for deconstruction of Copco No. 2 Dam on about May 1 of dam removal year 2 by closing the caterpillar gate at the power penstock intake structure to stop releases to Copco No. 2 Powerhouse and cease power generation. Controlled releases would be made through the gated spillway during the low flow period to draw the reservoir down from reservoir water surface elevation 2,486.5 feet to reservoir water surface elevation 2,481.5 feet in one day using the two right-hand side spillway gates.

The KRRC's Proposed Project would begin physical deconstruction of Copco No. 2 Dam with the removal of equipment and the concrete pad from the dike crest to provide room for demolition equipment and for construction access as described in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*. A temporary cofferdam would be constructed within the river channel to isolate the two left-hand spillway bays and the power penstock intake structure (Figure 2.7-2, tile 1 of 4). The spillway gates, hoists, bridge deck, and concrete crest structure would be removed to elevation 2,457.5 feet in the dry. The spillway gates and hoists would be removed by a large crane for loading onto highway trucks and heavy-haul trailers. The reinforced concrete spillway bridge deck and piers could be removed in pieces by hydraulic excavators, or in sections by conventional or diamond-wire sawcutting. Removal of the remainder of the spillway concrete structure would likely be performed using conventional drilling and blasting methods as each portion is dewatered.

For the conveyance tunnel, trash racks, a caterpillar gate, and a concrete structure would be removed, and the tunnel would be plugged "in the dry" (i.e., dewatered conditions). The left river bank would be restored, the temporary cofferdam would be removed, and the reservoir water surface would be allowed to stabilize at approximately elevation 2,463.5 through the left-hand dam breach.

Subsequently, the KRRC proposes a second temporary cofferdam would be constructed within the river channel to isolate the three remaining spillway bays on the right-hand side as described in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*. The spillway gates, hoists, bridge deck, and concrete crest structure would be removed to elevation 2,457.5 feet in the dry. Removal methods for the right-hand side spillway section would be similar to the removal of the left-hand side spillway section with a large crane removing the spillway gates and hoists, hydraulic excavators or sawcutting removing the reinforced spillway bridge deck and piers in pieces, and conventional drilling and blasting for the remainder of the spillway concrete structure as each portion is dewatered. After removal of the right-hand side spillway section is completed, the earth embankment and temporary cofferdam would be removed.

Similar to cofferdams at Copco No. 1, the Copco No. 2 cofferdams would be constructed using concrete rubble from Copco No. 1 Dam, plus borrow material from the existing site located on the hillslope above Copco No. 1 village that was used during dam construction and could be reactivated for cofferdam source material.

Table 2.7-4. Copco No. 2 Dam and Powerhouse Removal Proposal.

Feature[1]	KRRC Proposal
Concrete Dam	Remove
Spillway Gates, Structure	Remove
Power Penstock Intake Structure and Gate	Remove
Tunnel Portals[2]	Retain the tunnel, plug the tunnel portals with reinforced concrete
Embankment Section and Right Sidewall	Remove
Basin Apron and End Sill	Remove
Remnant Cofferdam Upstream of Dam	Remove
Wood-stave Penstock	Remove
Concrete Pipe Cradles	Remove
Steel Penstock, Supports, Anchors	Remove
Powerhouse (including mechanical and electrical equipment)	Remove
Powerhouse Hazardous Materials (transformers, batteries, insulation)	Remove
Powerhouse Control Center Building, Maintenance Building, Oil and Gas Storage Building	Remove
69-kV Transmission Line, 0.14 mile	Remove
Switchyard	Retain – the switchyard is not part of the Proposed Project
Tailrace Channel	Backfill
Copco Village (including former cookhouse/bunkhouse, garage/storage building, bungalow with garage, 3 modular houses, 4 ranch-style houses, and school house/community center)	Remove

[1] Feature as presented in Appendix B: *Definite Plan – Table 5.4-1*.
[2] Refers to Conveyance Tunnel and Overflow Spillway Tunnel shown in Figure 2.7-2.

The KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)* proposes that removal of the wooden-stave penstock and Copco No. 2 Powerhouse (Figure 2-7.2, tiles 2 of 4 and 3 of 4) would occur following closure of the caterpillar gate and shutdown of the powerhouse on or near May 1 of dam removal year 2. The wooden-stave penstock would be plugged with reinforced concrete at the tunnel portal at each end of the penstock. A third cofferdam would be constructed in the Copco No. 2 Powerhouse tailrace channel for removal of the powerhouse in the dry and during the low flow period. Sump pumps would be used to dewater the area and would be removed when they are no longer needed. The cofferdam would remain in place within the tailrace channel and would be backfilled to restore the left river bank. KRRC proposes to source cofferdam material from two areas near the powerhouse: (a) the wide bench/terrace where the maintenance shop to be demolished is located and/or (b) the toe of the hillslope nearest the powerhouse.

Site demobilization would occur after the dam site, staging areas, and concrete disposal site are restored, including topsoil and seed placement, where required as explained in the KRRC's Definite Plan (Appendix B: *Definite Plan – Section 5 Dam Removal Approach*) and the KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*).

Construction Access and Road Improvements

The KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)* details several road improvements to facilitate access for dam removal vehicles and equipment, to ensure road safety for the public during dam deconstruction activities. The KRRC proposes to return roads used for the Proposed Project to an acceptable state, including mitigating any potential reduction in function attributed to the dam removal work. The majority of the construction access roads and associated improvements that would be required for removal of Copco No. 2 Dam and Powerhouse would be the same as for the Copco No. 1 Dam and Powerhouse (Figure 2.7-2). In addition to the road improvements, the removal of Copco No. 2 Powerhouse and the wooden-stave penstock specifically would require one bridge replacement, road surface maintenance as necessary during or post-construction, temporary traffic controls during road improvements, and construction signage for one road. The construction access roads for the removal of Copco No. 2 Powerhouse and the wooden-stave penstock are shown within the Limits of Work on Figure 2.7-2, tiles 2 of 4 and 3 of 4. The delivery of off-road construction equipment, including cranes, large excavators, loaders, and large capacity dump trucks would be by special tractor-trailer vehicles operating under "wide load" restrictions and at appropriate speeds.

Staging Areas and Disposal Sites

The KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)* proposes the staging areas and disposal sites for removal of Copco No. 2 Dam and Powerhouse would be the same as for Copco No. 1 Dam and Powerhouse. The staging areas and disposal sites for removal of Copco No. 2 Powerhouse and the wooden-stave penstock are shown within the Limits of Work on Figure 2.7-2, tiles 2 of 4 and 3 of 4. Equipment staging areas for removal of the wooden-stave penstock and the powerhouse would be as shown in Figure 2.7-2, tile 3 of 4. Concrete rubble generated from removal of Copco No. 2 Dam would be permanently buried (without rail and rebar) in the disposal site described for Copco No. 1 Dam. After placement of the concrete debris, earth materials generated from removal of Copco No. 2 Dam would be used as cover over the concrete rubble at the disposal site. The disposal site would then be graded, sloped for drainage, and hydroseeded as detailed in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*.

Erosion monitoring would be completed on an annual basis for 5 years following placement to assess whether significant erosion and slope deterioration has occurred. If significant erosion occurs, the eroded area shall be repaired.

Imported Materials and Waste Disposal

Imported materials and waste disposal for removal of Copco No. 2 Dam and Powerhouse would be the same as for Copco No. 1 Dam and Powerhouse (Section 2.7.1.2 *Copco No. 1 Dam and Powerhouse*). In Table 2.7-5 below are the estimated quantities of materials generated during removal of Copco No. 2 Dam and Powerhouse, numbers of truck trips, and approximate haul distances for waste disposal in miles per round trip (miles RT) based on the information itemized in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)* and updated by KRRC based on further investigations since the release of the Definite Plan (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., November 2018).

Table 2.7-5. Estimated quantities of waste disposal for full removal of Copco No. 2 Dam.

Waste Material	In-Situ Quantity	Bulk Quantity[1]	Disposal Site[2]	Peak Daily Trips[3]	Total Trips[4]
Earth	1,800 yd^3	2,100 yd^3	On-site	2 units/50 trips (unpaved road)	100 trips (2 miles RT)
Concrete at Dam	6,600 yd^3	8,500 yd^3	On-site	2 units/50 trips (unpaved road)	390 trips (2 miles RT)
Concrete at Powerhouse	6,300 yd^3	8,100 yd^3	Tailrace area	Dispose at site (no hauling)	0
Rebar at Dam	300 tons	--	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	30 trips (62 miles RT)
Rebar at Powerhouse	100 tons	--	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	10 trips (56 miles RT)
Mech. and Elec. at Dam	300 tons	--	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	40 trips (62 miles RT)
Mech. and Elec. at Powerhouse	2,600 tons	--	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	320 trips (56 miles RT)
Building Waste	14 buildings 43,000 ft^2	9,500 yd^3	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	480 trips (56 miles RT)
Treated Wood (Wood-Stave Penstock)	700 tons	--	Landfill near Anderson, CA	1 units/2 trips (Interstate 5)	70 trips (280 miles RT)
Power Lines	6.7 miles of 69-kV and smaller	--	Transfer station near Yreka, CA	--	7 trips (62 miles RT)
Wood Utility Poles	100 poles	--	Transfer station near Yreka, CA	--	7 trips (62 miles RT)

Source: S. Leonard, AECOM as KRRC Technical Representative, pers. comm., November 2018

1 Volumes increased 30 percent for concrete rubble from reinforced concrete and 20 percent for loose earth materials.

2 Currently, solid waste is transferred approximately 45 miles from the Yreka Transfer Facility to the Dry Creek Landfill facility near White City Oregon.

3 Peak daily trips for each site are based on the number of vehicles (units) shown, operating within one 8-hour shift.

4 Total trips of earthfill or concrete assume off-highway articulated trucks with a nominal load capacity of 22 yd^3. Total trips for hauling rebar using truck tractor-trailers is based on 10 tons per trip. Total trips for hauling mechanical and electrical items using truck tractor-trailers is based on 8 tons per trip. Total trips for building waste using truck tractor-trailers is based on 10 yd^3 per trip. Mileage is reported in miles per round trip (miles RT).

Potential hazardous materials at Copco No. 2 Dam and Powerhouse include creosote-treated wooden-stave (redwood) penstock, treated wood, asbestos, batteries, bearing and hydraulic control system oils, flammable and nonflammable gases, flammable and combustible liquids, mercury in older light switches, contaminated soils near painted exterior equipment, coatings containing heavy metals in the powerhouse, on the exterior surfaces of the steel penstocks, air vents, and other painted materials, a fueling facility containing above-ground gasoline (1,000 gallon) and diesel (500 gallon) tanks, and underground septic systems used for seven residences near the powerhouse. All hazardous materials would be handled and disposed of as hazardous waste at an approved hazardous waste facility in accordance with applicable federal and state regulations. Additional details are provided in the KRRC's Hazardous Material Management Plan (Appendix B: *Definite Plan – Appendix O3*) and discussed in Section 3.21 *Hazards and Hazardous Materials* of this EIR.

2.7.1.4 Iron Gate Dam and Powerhouse

Deconstruction Activities

The KRRC's Proposed Project would remove the Iron Gate Dam, the Iron Gate Powerhouse, and associated structures and equipment as described in the KRRC's Definite Plan (Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*. The KRRC proposes removal between June 1 and September 30 of dam removal year 2 by lowering the reservoir water surface elevation, removing the fish facilities near the base of the dam, excavating the dam, removing the Iron Gate Dam associated structures and their equipment summarized in Table 2.7-6, and restoring the dam site after construction activities are completed. Modifications to Iron Gate Hatchery, including removal of the fish trapping and holding facilities located on random fill downstream of the dam, would be completed prior to drawdown activities so that Iron Gate Hatchery operations would continue during reservoir drawdown.

Features to be removed or retained for Iron Gate Dam and Powerhouse are summarized in Table 2.7-6 and are discussed briefly below. Additional details are presented in the KRRC's Definite Plan (Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*.

Table 2.7-6. Iron Gate Dam and Powerhouse Removal and Decommissioning Proposal.

Feature[1]	KRRC Proposal
Embankment Dam, Cutoff Walls	Remove
Penstock Intake Structure and Footbridge	Remove
Penstock	Remove
Water Supply Pipes and Aerator	Remove
Spillway Structure	Retain and bury to extent practicable
Powerhouse (including mechanical and electrical equipment)	Remove
Powerhouse Hazardous Materials (transformers, batteries, insulation)	Remove
Powerhouse Tailrace Area	Backfill
Fish Trapping and Holding Facilities on Dam (fish ladder and trapping and holding facilities)	Remove
Iron Gate Fish Hatchery	Fish ladder and holding tanks at the toe of the dam would be removed, as would the cold-water supply for the hatchery; these facilities would be relocated such that the hatchery remains operational for eight years after the removal of Iron Gate Dam (see also Section 2.7.6)
Switchyard	Remove
69-kV Transmission Line, 0.5 mi	Remove
Diversion Tunnel Intake Structure and Footbridge	Remove
Diversion Tunnel and Portals	Retain the tunnel, plug the tunnel portals with reinforced concrete

Feature[1]	KRRC Proposal
Diversion Tunnel Control Tower, Hoist, and Gate	Remove above finished-grade portion and retain below finished-grade portion
Additional Ancillary Facilities (e.g., Communication Buildings, Restrooms and Two Residences)[3]	Remove

[1] Feature as presented in Appendix B: *Definite Plan – Table 5.5-1*.
[2] Features to be partially removed would involve long-term maintenance costs, including the preservation of any exposed items with coatings containing heavy metals.
[3] These facilities are discernible in Figure 2.7-4 although they not itemized in Appendix B: *Definite Plan – Table 5.5-1.*

The KRRC proposes to remove Iron Gate Dam and its associated facilities following spring runoff of dam removal year 2 (approximately June 1). The embankment dam crest would be retained at a level needed for flood protection, with a minimum flood release capacity of approximately 7,000 cfs in July (reservoir water surface elevation 2,242.3 feet) and 3,000 cfs in August and September (reservoir water surface elevation 2,194.3 feet), in order to accommodate the passage of at least a 1 percent probable flood for that time of year. Excavation of the embankment section at Iron Gate Dam would not begin before June 1 of dam removal year 2, and it would be complete by September 30 to minimize the risk of flood overtopping. During excavation, rockfill would be temporarily stockpiled for placement on the downstream slope of a temporary cofferdam. Throughout excavation, access would be provided to the gate control house at the base of the intake tower for flow control.

The fish hatchery facilities near the downstream toe of embankment, including the fish ladder and the holding tanks, would be removed once the area is dry. The water supply features for the fish hatchery facilities would be removed as well. Note: modifications to Iron Gate Hatchery would be completed prior to drawdown activities so that Iron Gate Hatchery operations would continue during reservoir drawdown.

A cofferdam would be constructed in the tailrace channel to facilitate removal of the Iron Gate Powerhouse. The cofferdam would be comprised of remaining portions of the Iron Gate Dam embankment (i.e., the dam embankment would be excavated height wise and widthwise until only the cofferdam remains). Sump pumps would be used to dewater the area and then would be removed following construction activities. The Iron Gate cofferdam would be breached prior to the J.C. Boyle cofferdam-breach so that the sediment released by the upstream breach is not trapped at the Iron Gate cofferdam and subsequently released in a larger, combined event. Breaching of the Iron Gate cofferdam would occur by notching below the reservoir level (expected to be below reservoir water surface elevation 2,186.3 feet). The maximum breach outflow from the cofferdam at Iron Gate Dam is estimated to be approximately 5,000 cfs. Following the cofferdam breach, any remaining embankment materials would be removed from the river channel while the river channel is wet, during the low flow period. The diversion tunnel intake structure and topple gate control tower would be removed and the tunnel and shaft portals would be plugged with reinforced concrete. The cofferdam materials would then be removed.

As explained in the KRRC's Definite Plan (Appendix B: *Definite Plan – Section 5 Dam Removal Approach)* and the KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan − Appendix H*), site demobilization would occur after restoration of the dam site, right abutment disposal site, staging areas and concrete disposal site. This restoration would include topsoil and seed placement where appropriate.

Construction Access and Road Improvements

An overview of construction access roads required for removal of Iron Gate Dam and Powerhouse, and associated work, are shown in Figure 2.7-4. Existing conditions of the highways, local roads, and structures to be used were observed in the field to identify deficiencies and determine if improvements are necessary for mobilization and/or hauling during construction and demolition activities. The KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)* details several road improvements to facilitate access for dam removal vehicles and equipment and to ensure public safety during dam deconstruction activities. The KRRC proposes to return roads used for the project to an acceptable state, including mitigating any potential reduction in function attributed to the dam removal work.

The road improvements identified for the removal of Copco No. 1 are also required for access to Iron Gate Dam (see Section 2.7.1.2 *Copco No. 1 Dam and Powerhouse – Construction Access and Road Improvements*). In addition, the Iron Gate Dam removal would require surface maintenance of two roads during or post-construction, temporary traffic controls during road improvements, and construction signage at one bridge. The delivery of off-road construction equipment, including cranes, large excavators, loaders, and large capacity dump trucks would be performed by special tractor-trailer vehicles operating under "wide load" restrictions and would travel at appropriate speeds.

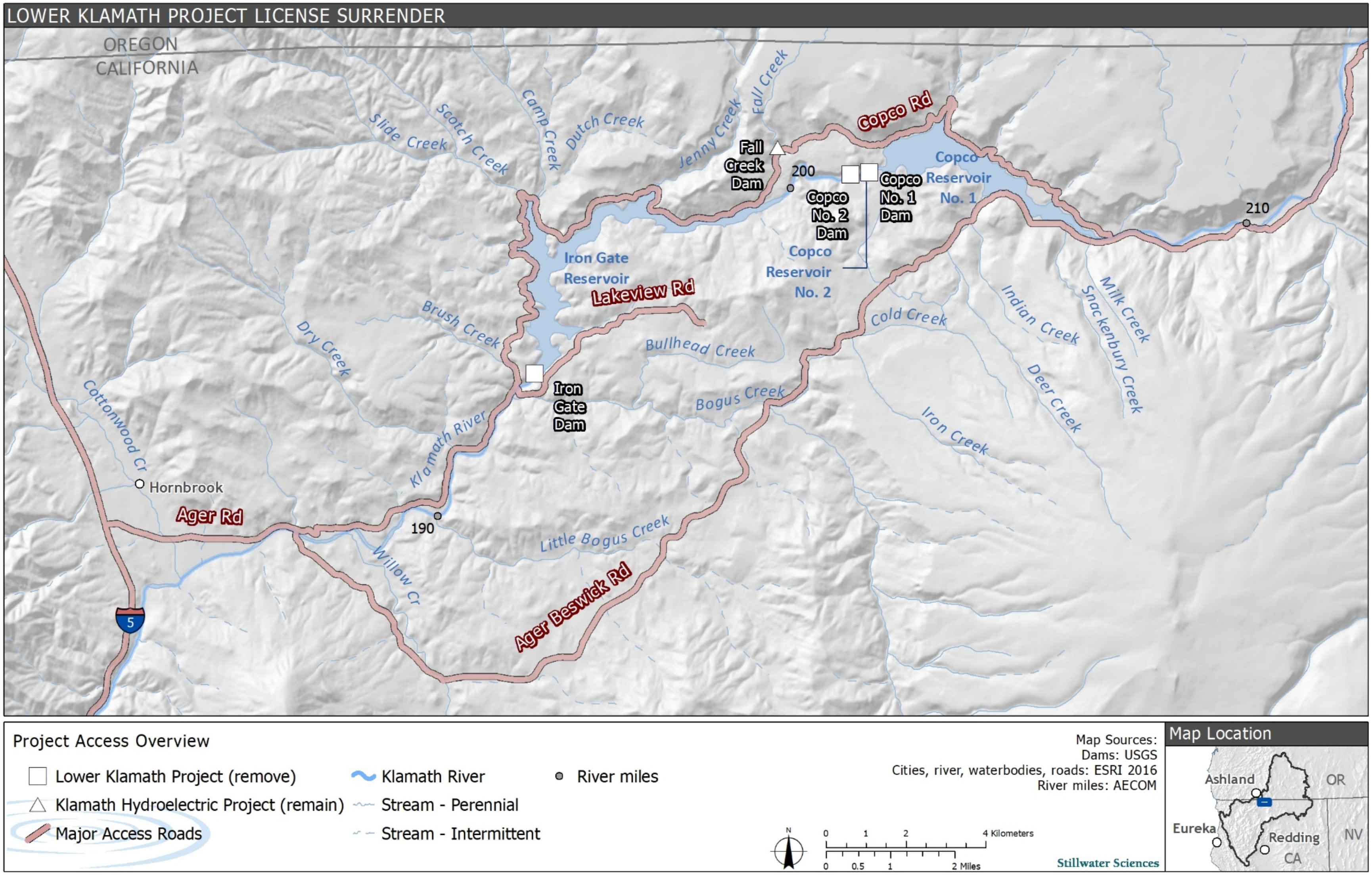

Figure 2.7-3. Lower Klamath Project Access Overview.

Staging Areas and Disposal Sites

The KRRC's Proposed Project construction staging areas and a disposal site for removal of Iron Gate Dam and Powerhouse are shown within the Limits of Work in Figure 2.7-4 and detailed further in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*. Equipment or material staging areas at the Iron Gate Dam site include 7.7 acres above the left abutment of the dam, 1.4 acres southwest of the disposal site, and 1.4 acres northeast of the disposal site (Figure 2.7-4, tiles 1 of 2, 2 of 2). A 1.9-acre area near the right abutment downstream of the dam (currently occupied by two PacifiCorp residences and outbuildings) could be used for construction offices. The staging areas would be prepared by clearing vegetation and minor grading, and would be restored by minor grading, decompaction, and hydroseeding consistent with the upland planting zones in the KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan − Appendix H*). Staging of mechanical and electrical debris would likely occur at the downstream toe of the dam in the parking area and the area of the fish collection facilities (Figure 2.7-4, tile 1 of 2).

The KRRC proposes that most of the earth materials and all of the concrete rubble generated from removal of the Iron Gate facilities would be permanently buried on-site in a disposal area covering approximately 36 acres located on PacifiCorp property approximately 1 mile south of the dam (Figure 2.7-4, tile 1 of 2). The disposed material would be placed to a maximum fill height of about 50 feet and graded to conform to the existing topography. Concrete rubble would be covered by a minimum of 3 feet of earth materials. Final grading of the disposal site would include relatively flat slopes (8H:1V to 5H:1V) to reduce the potential for erosion. Preparation of the disposal site would require clearing of vegetation and stripping and stockpiling of topsoil for later use during restoration of the disposal site. After final grading for drainage and aesthetics, the disposal site would be covered with topsoil and hydroseeded. Erosion monitoring would be completed on an annual basis for five years following placement to assess whether significant erosion and slope deterioration has occurred. If significant erosion occurs, the eroded area shall be repaired to the satisfaction of the appropriate regulatory agency. Additional details for the KRRC's Proposed Project disposal sites for Iron Gate Dam are provided in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)*.

Earth materials excavated from the dam would be placed in the existing concrete-lined side-channel spillway, chute, and flip-bucket terminal structure (located on the right abutment of the dam) to the extent practicable for restoration. Finished grades of the backfill would be no steeper than approximately 4H:1V. Following backfilling, the uphill portion of the spillway excavation would still be visible. After final grading for drainage and aesthetics, the disposal site would be covered with topsoil and hydroseeded. Compaction other than by equipment travel would not be necessary.

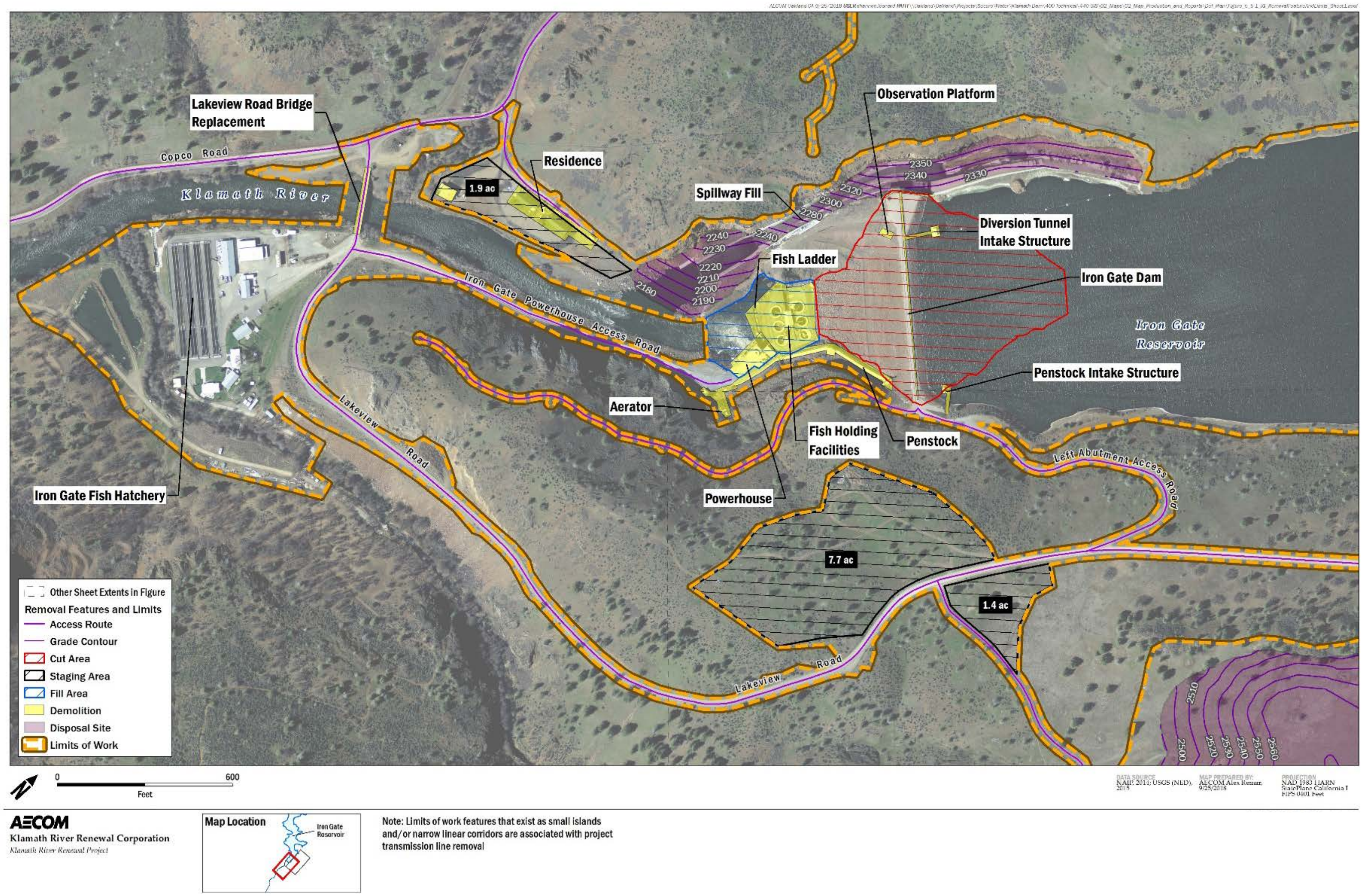

Figure 2.7-4. Iron Gate Dam Removal Features and Limits of Work (1 of 2).

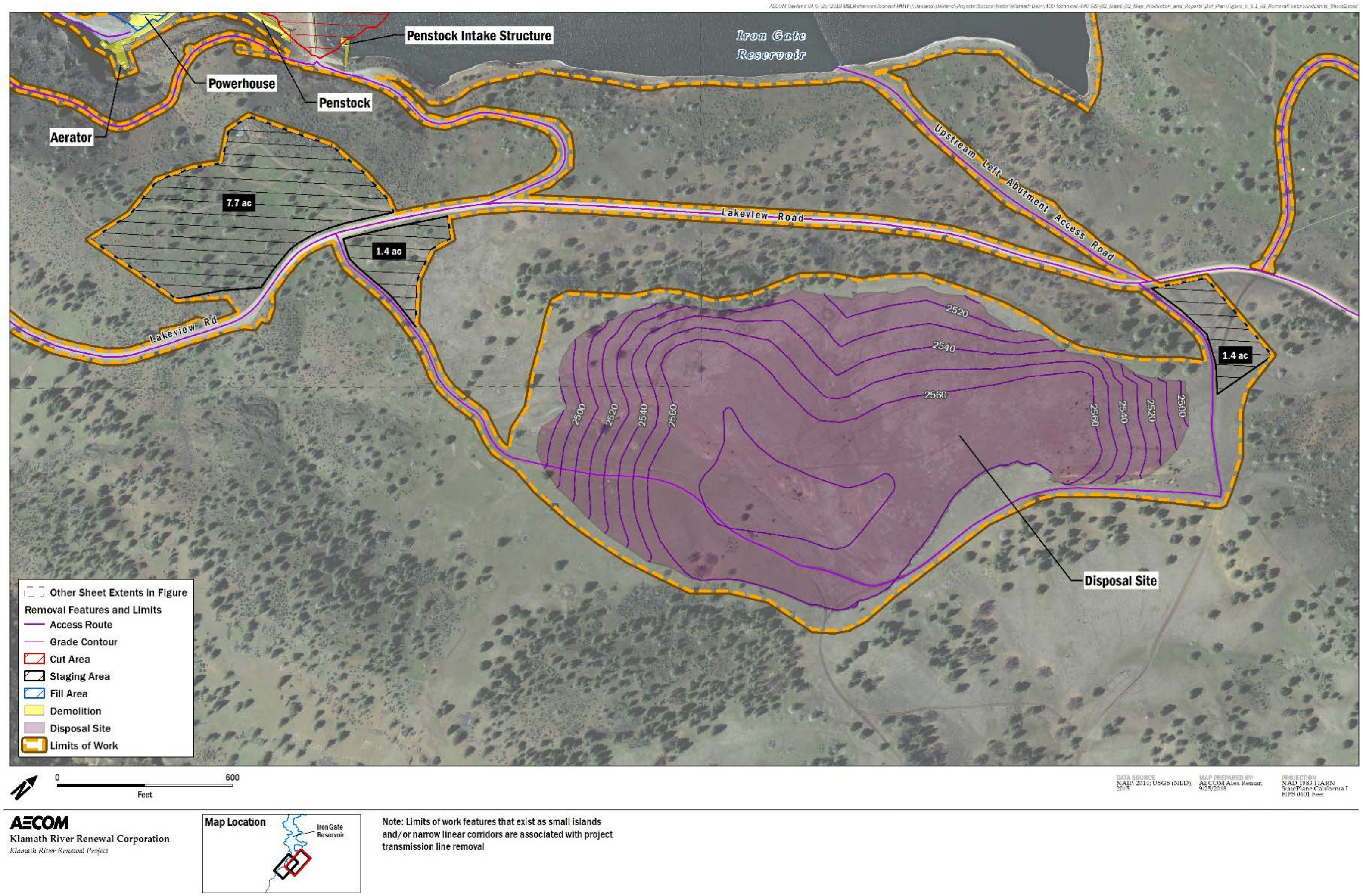

Figure 2.7-4. Iron Gate Dam Removal Features and Limits of Work (2 of 2).

Imported Materials and Waste Disposal

KRRC proposes to import some materials to support dam removal. Those materials include gravel surfacing from a commercial quarry for temporary haul roads, topsoil, seed and mulch materials, and minor quantities of ready-mix concrete and reinforcing steel from local commercial sources for tunnel plugs. Additional imported materials would be necessary for road surface improvements, signage, and the bridge replacement. The KRRC's Proposed Project modification of the diversion tunnel and installation of a new gate in the existing gate structure would require importing mechanical equipment, as well as additional reinforcing steel and potentially ready-mix concrete for lining the diversion tunnel if inspections determine it is necessary.

Estimated quantities of materials generated during removal of Iron Gate Dam and Powerhouse, numbers of truck trips, and approximate haul distances for waste disposal in miles per round trip (miles RT) are detailed in the KRRC's Definite Plan *(*Appendix B: *Definite Plan – Section 5 Dam Removal Approach)* and updated information on waste disposal details has been provided by KRRC based on further investigations since the Definite Plan was released (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., November 2018). Please see Table 2-7.7 for a summary of the updated information on waste disposal. Excavated earth would be disposed on-site at either the spillway fill area or the main disposal site. Excavated concrete would be placed in the on-site disposal site. Rail and reinforcing steel would be separated from the concrete prior to placement in the disposal area and hauled to a local recycling facility. All mechanical and electrical equipment would be hauled to a suitable commercial landfill or salvage collection point (e.g., Yreka Transfer Station, Yreka, CA).

Table 2.7-7. Estimated quantities of waste disposal for full removal of Iron Gate Dam.

Waste Material	In-Situ Quantity	Bulk Quantity[1]	Disposal Site[2]	Peak Daily Trips[3]	Total Trips[4]
Earth	155,000 yd^3	170,000 yd^3	On-site spillway fill area	12 units/ 800 trips (unpaved road)	8,640 trips (0.5 miles RT)
Earth	912,000 yd^3	1,087,000 yd^3	On-site	12 units/ 800 trips (unpaved road)	48,640 trips (2 miles RT)
Concrete	15,800 yd^3	20,700 yd^3	On-site	2 units/ 50 trips (Copco Road)	950 trips (2 miles RT)
Rebar	1,000 tons	--	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	100 trips (54 miles RT)
Mech. and Elec.	1,200 tons	--	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	150 trips (54 miles RT)
Building Waste	8 buildings; 10,400 ft^2	2,300 yd^3	Transfer station near Yreka, CA	1 units/5 trips (Copco Road)	120 trips (54 miles RT)
Power lines	0.5 miles of 69-kV	--	Transfer station near Yreka, CA	--	1 trip (54 miles RT)

Waste Material	In-Situ Quantity	Bulk Quantity[1]	Disposal Site[2]	Peak Daily Trips[3]	Total Trips[4]
Wood Utility Poles	30 poles	--	Transfer station near Yreka, CA	--	2 trips (54 miles RT)

Source: S. Leonard, AECOM as KRRC Technical Representative, pers. comm., November 2018

[1] Volumes increased 30 percent for concrete rubble and 20 percent for loose earth materials.

[2] Currently, solid waste is transferred approximately 45 miles from the Yreka Transfer Facility to the Dry Creek Landfill facility near White City Oregon.

[3] Peak daily trips for each site are based on the number of vehicles (units) shown, operating within one 8-hour shift.

[4] Total trips of earthfill or concrete assume off-highway articulated trucks with a nominal load capacity of 22 yd^3. Total trips for hauling rebar using truck tractor-trailers is based on 10 tons per trip. Total trips for hauling mechanical and electrical items using truck tractor-trailers is based on 8 tons per trip. Total trips for building waste using truck tractor-trailers is based on 10 yd^3 per trip. Mileage is reported in miles per round trip (miles RT).

Potential hazardous materials at Iron Gate Dam and Powerhouse include asbestos, batteries, bearing and hydraulic control system oils, treated wood, flammable and nonflammable gases, flammable and combustible liquids, mercury in older light switches, contaminated soils near painted exterior equipment, coatings containing heavy metals in the powerhouse, on the exterior surfaces of the steel penstocks, air vents, and other painted materials, and underground septic systems in use for the restroom and two residences near the dam. All hazardous materials would be handled and disposed of as hazardous waste at an approved hazardous waste facility in accordance with applicable federal and state regulations. Additional details and their disposal are provided in the KRRC's Hazardous Material Management Plan (Appendix B: *Definite Plan – Appendix O3*) and disposal is discussed in Section 3.21 *Hazards and Hazardous Materials* of this EIR.

2.7.1.5 Estimated Deconstruction Workforce and Work Shifts

The size of the deconstruction workforce at each site would vary, and the peak times for construction would be staggered. Table 2.7-8 presents a summary of the projected workforce needed for the Proposed Project.

Table 2.7-8. Workforce Projections for Dam Removal for the Proposed Project.

Dam	Estimated Average Deconstruction Workforce	Duration	Estimated Peak Workforce	Peak Period
J.C. Boyle*	30 people	9 months	45 people	Jun−Sep dam removal year 2
Copco No. 1	35 people	12 months	55 people	Apr–Nov dam removal year 2
Copco No. 2	30 people	6 months	40 people	Apr−Sept dam removal year 2
Iron Gate	40 people	10 months	80 people	Jun−Sep dam removal year 2

* J.C. Boyle Dam is included in this table as some of the traffic flow may use roads in California (e.g., I-5 to OR 66)

Source: Appendix B: *Definite Plan – Section 5*

The Proposed Project includes two shifts of workers to deconstruct each of the three California dams (Copco No. 1, Copco No. 2, and Iron Gate). At each dam the first work shift would be 6 a.m. to 4 p.m. and the second work shift would be 6 p.m. to 4 a.m. This would allow for 2-hour breaks between shifts for refueling and maintenance. Blasting would occur at each dam (see Sections 2.7.1.2 through 2.7.14) and would be restricted to the period from 8 a.m. to 6 p.m. (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., September 2018).

2.7.2 Reservoir Drawdown

The KRRC proposes that drawdown of J.C. Boyle, Copco No. 1 (Copco Lake), and Iron Gate reservoirs would take place between November 1 of dam removal year 1 and March 15 of dam removal year 2, as detailed in the KRRC's Reservoir Drawdown and Diversion Plan (Appendix B: *Definite Plan*). Copco No. 1 Reservoir drawdown would occur from November 1 of dam removal year 1 to March 15 of dam removal year 2, while the drawdown of J.C. Boyle and Iron Gate reservoirs would occur from January 1 to March 15 of dam removal year 2. Drawdown of Copco No. 2 Reservoir would not be necessary until after Copco No. 1 Dam has been breached to final grade in May of dam removal year 2 because it will not impound a significant volume of water or sediment.

KRRC proposes to begin drawdown of Copco No. 1 Reservoir beginning on November 1 of dam removal year 1. Copco No. 1 is the largest Lower Klamath Project reservoir. The drawdown is expected to be completed by March 15 of dam removal year 2, at which point the Klamath River would most likely re-occupy its historical active channel (Figures 2.7-5 and 2.7-6). The proposed drawdown period is integral to the project in that it would provide for power generation revenues for the period specified in the KHSA and it would undertake reservoir drawdown at a period when winter flows and levels of suspended sediment are naturally high in river and only a portion of fish populations are likely to be present in the mainstem Klamath River immediately downstream of the Hydroelectric Reach (Figure 2.7-1). Most fish are in tributaries or further downstream during the period when mainstem concentrations of suspended sediments due to dam removal would be the highest, and in general many native aquatic species are adapted to naturally high levels of suspended sediment during the winter through avoidance and tolerance behaviors. Additional proposed measures to reduce sediment-related impacts to salmonids during and following Proposed Project drawdown activities are discussed in Section 2.7.8.1 *Aquatic Resource Measures*.

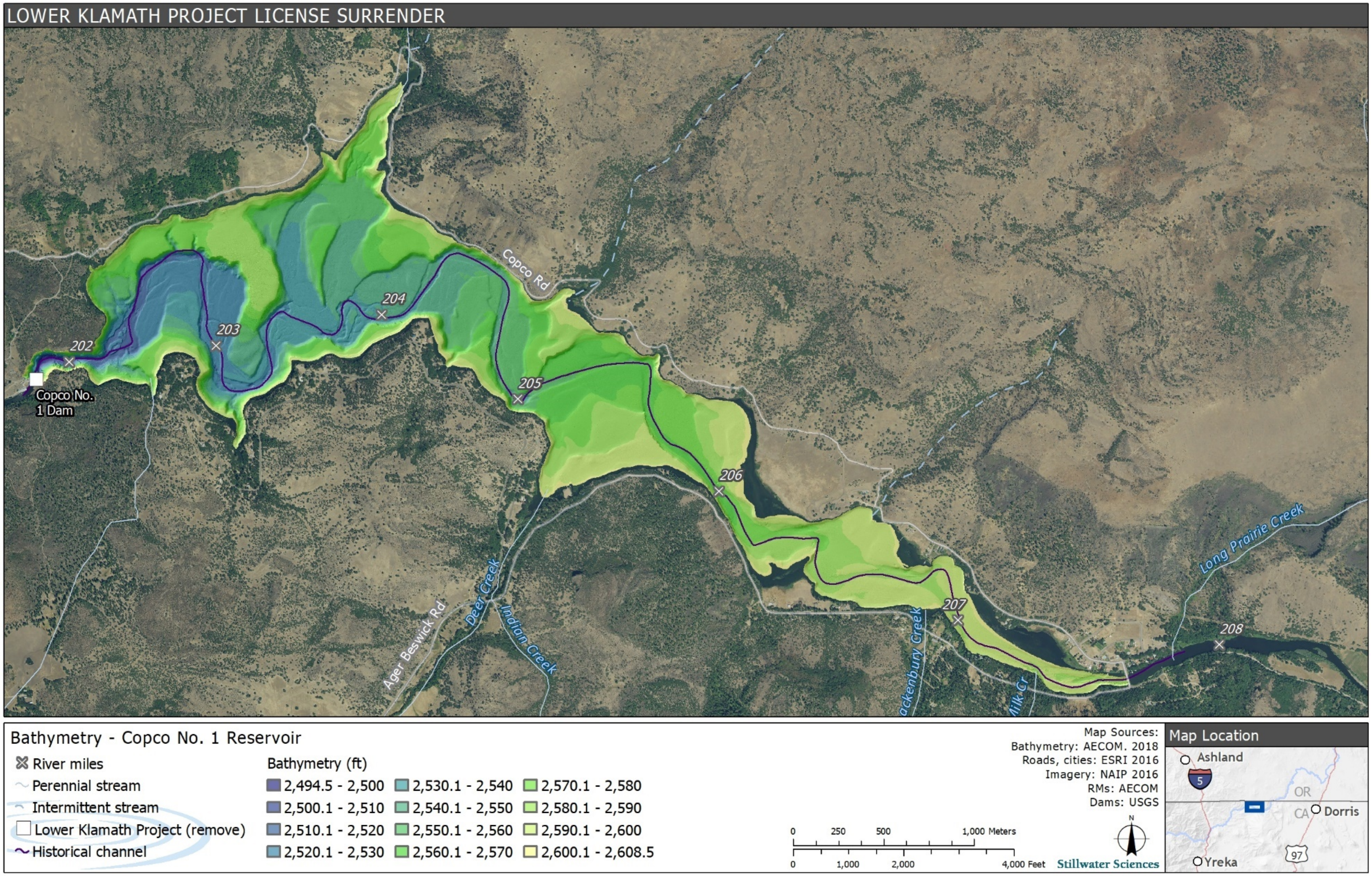

Figure 2.7-5. Copco No. 1 Reservoir Bathymetry.

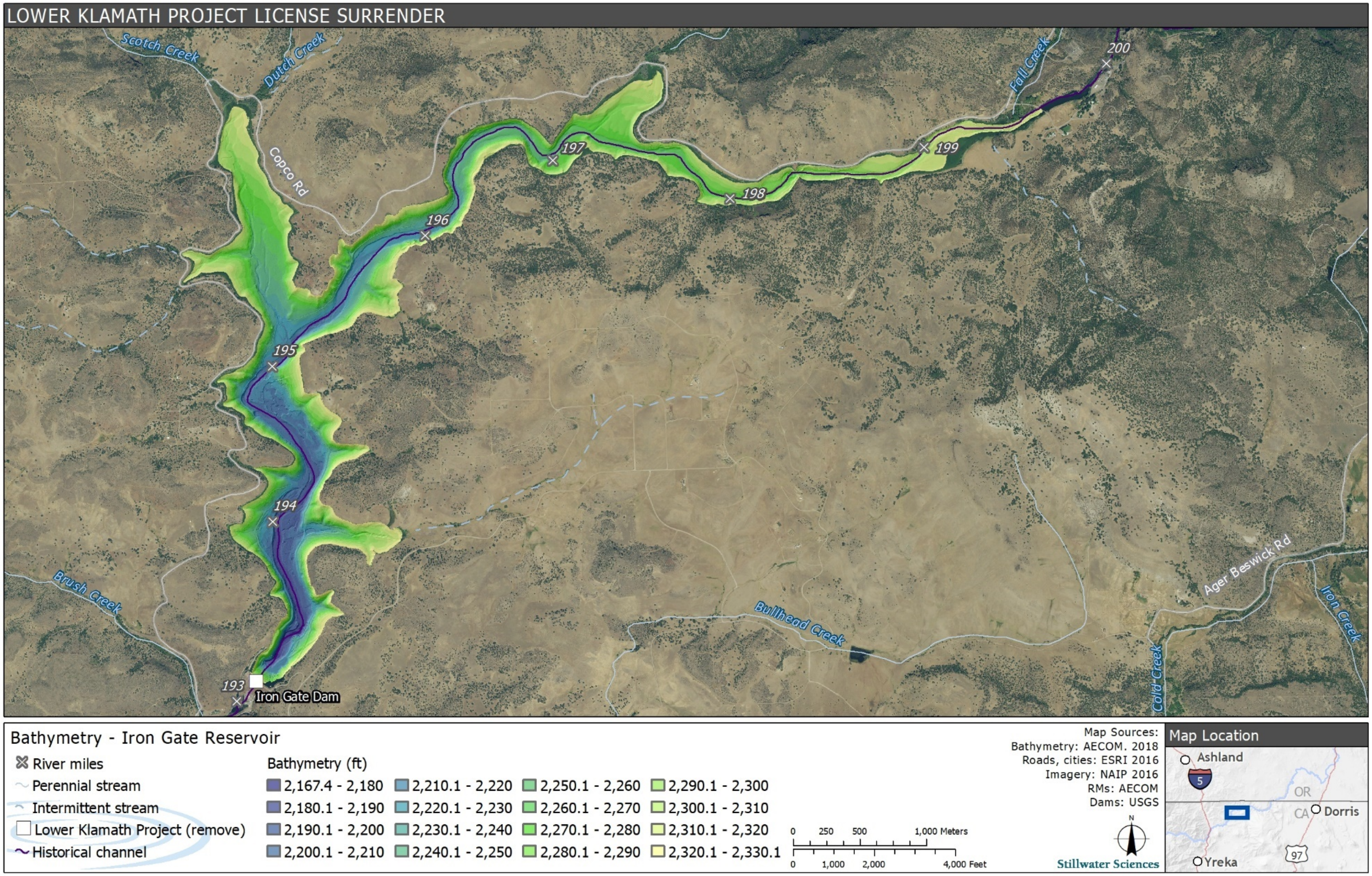

Figure 2.7-6. Iron Gate Reservoir Bathymetry.

For J.C. Boyle and Iron Gate Dams, power generation would end on January 1 of dam removal year 2. Power generation at Copco No. 1 Dam would end after the reservoir reaches the minimum operating level at reservoir surface elevation 2,604.5 feet, in November of dam removal year 1. To offset lost revenue from shutting down Copco No. 1 Powerhouse prior to January 1 of dam removal year 2, power generation at Copco No. 2 Dam could continue for up to four months after January 1 of dam removal year 2 (or until May 1 of dam removal year 2), if Copco No. 2 power generating equipment proves capable of operating under sediment-laden flow conditions. This EIR assumes continued production at Copco No. 2, as the need to halt production is speculative. If the Copco No. 2 Powerhouse is not capable of operating under sediment-laden conditions, then drawdown of this reservoir would still use the penstock. Reservoir drawdown below the minimum operating level would commence at each dam once power generation has ceased.

For all reservoirs, the minimum drawdown rate would be 2 feet per day and the maximum drawdown rate would be 5 feet per day, until drained. Although the new gates at Copco No. 1 and Iron Gate dams would be able to accommodate higher drawdown rates, the maximum drawdown rate of 5 feet per day is proposed by KRRC as a conservative value based upon slope stability analyses conducted for each of the Lower Klamath Project reservoirs.

According to the KRRC's Reservoir Drawdown and Diversion Plan (Appendix B: *Definite Plan*), the drawdown of Copco No. 1 and Iron Gate reservoirs would be managed through automated gate control systems with operator oversight, where inputs to determine the amount of gate opening at each reservoir would include continuous measurement of reservoir levels by remote sensor. The gate control system would incrementally open (or close) the gate to increase (or decrease) flow through the diversion tunnel (14-foot by 16-foot) to maintain the reservoir drawdown at an approximately constant rate. This will allow the project to maintain embankment and reservoir rim stability even as reservoir inflows vary. For example, flows may vary due to storms or changes in upstream reservoir releases.

Once the Copco No. 1 and Iron Gate reservoirs have been fully drawn down, the gates would remain in the fully open position to limit reservoir refilling during storm events. Any storm inflows large enough to cause partial refilling of the reservoir would pass through the spillway, unless spillway outflows reach a pre-determined level (13,000 cfs for Copco No. 1 and 15,000 cfs for Iron Gate). If these levels are reached the gates would be closed until the flow drops below this level to avoid high water levels that would impact the Copco No. 2 Powerhouse (which could still be operating until May 1).

During dam removal, the drawdown of Iron Gate Reservoir would need to maintain enough capacity to pass a 1 percent probable flood for that time of the year to reduce the potential for flow to overtop the dam embankment. The following minimum flood release capacities by month would be maintained during drawdown of Iron Gate Reservoir:

- June—approximately 7,700 cfs
- July—approximately 7,000 cfs
- August/September—approximately 3,000 cfs

Drawdown of J.C. Boyle Reservoir would be initially controlled by the capacity of the opened spillway, followed by the capacity of the opened power intake. Once the reservoir stabilizes with spillway and intake fully open, the diversion culverts would be opened, and drawdown would only be controlled by the capacity of the diversion culverts, which is approximately 6,000 cfs at the spillway elevation. For storm flows that refill the reservoir before deconstruction, higher discharge rates would be experienced over the spillway. Drawdown of J.C. Boyle Reservoir would maintain a minimum flood release capacity of 3,500 cfs, in order to accommodate the passage of at least a 1 percent probable flood for September and prevent flood overtopping of the dam embankment during dam removal.

The resulting range of release flows due to drawdown of the three larger reservoirs is provided in Table 2-7.8. Release flows would add water to the otherwise existing flows in the river (i.e., Keno Reservoir releases and tributary inflows). The percent increase in the Klamath River caused by the minimum average and maximum average release flows compared to the 2-year and 10-year peak flows in the Klamath River at individual locations for each reservoir are also detailed in Table 2-7.8. The 2-year and 10-year peak flows are calculated from the available USGS flow gage data in the Klamath River below J.C. Boyle Dam for J.C. Boyle Reservoir, in the Klamath River downstream of Fall Creek at the upstream end of Copco No. 1 Reservoir, and in the Klamath River downstream of Iron Gate Dam for Iron Gate Reservoir. Details for the release flow modeling and the associated assumptions are provided in Section 3.6.5.1 *Flood Hydrology* of this EIR.

Table 2.7-9. Range of Release Flows from Reservoirs due to Drawdown.

Reservoir	Reservoir Depth[1] (feet)	Reservoir Volume[2] (acre-feet)	Minimum Average Release Flow (cfs)[3]	Minimum Average as Percent of 2-Year Peak Flow in Klamath River[4]	Minimum Average as Percent of 10-Year Peak Flow in Klamath River[5]	Maximum Average Release Flow (cfs)[6]	Maximum Average as Percent of 2-Year Peak Flow in Klamath River[4]	Maximum Average as Percent of 10-Year Peak Flow in Klamath River[5]
J.C. Boyle	41.5	2,267	19	0.4	0.2	138	3	1
Copco No. 1	111.5	33,724	288	5	3	762	13	7
Iron Gate	155	50,941	435	7	3	828	14	6

1 Reservoir depth is the difference between the initial water surface elevation (normal operating level at J.C. Boyle or spillway elevation at Copco No. 1 and Iron Gate) and invert elevation of the reservoir diversion structure.

2 Reservoir volume based on a 2003 bathymetric survey (Eilers and Gubala 2003).

3 Minimum assumes 59 days to drain reservoir.

4 2-Year peak flow (4,736 cfs for J.C. Boyle, 5,974 cfs for Copco, and 5,942 cfs for Iron Gate) based on flood frequency results in the Klamath River below J.C. Boyle Dam for J.C. Boyle, in the Klamath River downstream of Fall Creek at the upstream end of Copco No. 1 Reservoir for the Copco No. 1, and in the Klamath River below Iron Gate Dam for Iron Gate. Period of record 1932–2017 for J.C. Boyle, 1932–2017 for Copco No. 1, and 1961–2016 for Iron Gate (AECOM et al. 2017).

5 10-Year peak flow (9,438 cfs for J.C. Boyle; 11,340 cfs for Copco; and 14,912 cfs for Iron Gate) based on flood frequency results in the Klamath River below J.C. Boyle Dam for J.C. Boyle, in the Klamath River downstream of Fall Creek at the upstream end of Copco No. 1 Reservoir for the Copco No. 1, and in the Klamath River below Iron Gate Dam for Iron Gate. Period of record 1932–2017 for J.C. Boyle, 1932–2017 for Copco No. 1, and 1961–2016 for Iron Gate (AECOM et al. 2017).

6 Maximum assumes continuous 5 feet per day drawdown.

For J.C. Boyle Reservoir, the increase in flow to the Klamath River due to drawdown is expected to range from less than 1 percent to approximately 3 percent of the 2-year peak flow in the Klamath River below J.C. Boyle Dam. For Copco No. 1 Reservoir, the increase is expected to be between 5 percent and 13 percent of the 2-year peak flow in the Klamath River downstream of Fall Creek near the upstream end of Copco No. 1 Reservoir. The increase in flow from Iron Gate Reservoir is expected to be between 7 percent to 14 percent of the 2-year peak flow in the Klamath River below Iron Gate Dam. The maximum additional discharge in the Klamath River during drawdown of all the Lower Klamath Project reservoirs combined would be approximately 6,000 cfs. The minimum drawdown rate (and minimum average release flows) would likely occur during large storm events, such that the increase in flow to the river due to dam removal would be a small percentage of the 2-year peak flow (i.e., less than 1 to 7 percent) and an even smaller percentage of the 10-year peak flow (i.e., less than 1 to 3 percent) (Table 2.7-8). During dry periods, the reservoirs could be drawn down more quickly, resulting in a larger percent increase in Klamath River flows due to drawdown releases compared to the 2-year peak flow (i.e., 3 to 14 percent) or the 10-year peak flow (i.e., 1 to 7 percent). In comparison to the magnitude of the 2-year and 10-year peak flows, the incremental increase in flow due to reservoir drawdown would be minimal.

2.7.3 Reservoir Sediment Deposits and Erosion During Drawdown

J.C. Boyle, Copco No. 1, and Iron Gate reservoirs contain a significant amount of highly erodible sediment with approximately 1/3 to 2/3 of this sediment anticipated to be transported downstream with the water during drawdown. Over 80 percent of the reservoir sediments are fine sediment (organics, silts, and clays), which are expected to remain suspended in the Klamath River flow as it moves downstream and out into the Pacific Ocean. Coarse sediment (i.e., sand and larger) transport would occur more slowly depending on the hydrologic conditions with deposition of coarser sediment from dam removal expected to primarily occur between the reservoirs and the confluence of the Klamath River and the Shasta River. Sediment transport from dam removal would not be expected to have a significant effect on the streambed downstream of Shasta River (USBR 2012b).

Sediment in the Lower Klamath Project reservoirs is primarily composed of silt-sized particles of organic material from dead algae, silt, and clay (fine sediment) with lesser amounts of cobble and gravel (coarse sediment) (USBR 2012a). The distribution of sediment deposits varies within each of the reservoirs. In J.C. Boyle Reservoir, sediment primarily resides in the area nearest the dam, with measured sediment thicknesses ranging from 0 feet in the middle and upper portions of the reservoir to over 20 feet near the dam. Figure 2.7-7 presents the estimated average sediment thickness throughout the reservoir based on measurements. Both Copco No. 1 and Iron Gate reservoirs have generally even distributions of sediment with thicknesses increasing towards the dams. Figures 2.7-8 and Figure 2.7-9 show the estimated average sediment thickness based on position in the reservoir. The measured thickness of Copco No. 1 Reservoir sediment ranges from approximately 1.2 feet to approximately 10 feet. The maximum deposition within the thalweg (original river channel) of Iron Gate Reservoir is around 5 feet, with a measured deposition thickness of nearly 10 feet in the Jenny Creek arm of the reservoir, while the minimum measured sediment thickness is approximately 0.3 feet near the upstream end of the reservoir.

No detailed measurements (bathymetry or sediment sampling results) are available for the smaller (approximately 73 acre-feet) Copco No. 2 Reservoir. Sediment sampling was attempted in Copco No. 2, but no samples were collected due to the absence of accumulated sediment deposits (USBR 2011b). This condition likely results from the presence of the larger, upstream Copco No. 1 Dam that was completed seven years prior to Copco No. 2 Dam, cutting off upstream sediment supply to the Copco No. 2 Reservoir. Although there appears to be a lack of historical sediment deposits in Copco No. 2 reservoir under current conditions, during drawdown of the two upstream reservoirs J.C. Boyle and Copco No. 1, a large volume of sediments would be transported into Copco No. 2 Reservoir. Estimates of the particle trapping efficiency of Copco No. 2 Reservoir can be made over a range of grain sizes using known relations between reservoir geometry, the range of expected flows during drawdown, and assumptions regarding mixing conditions (Nazaroff and Alvarez-Cohen 2001). Given an expected flow range of 1,000 cfs to 13,000 cfs within Copco No. 2 Reservoir during drawdown operations, estimated settling velocities suggest that no particle trapping would occur in this reservoir for particles smaller than 0.2 millimeters (fine sand) and 1.0 millimeters (coarse sand). While coarser substrates may be trapped in Copco No. 2 Reservoir between 1,000 cfs to 13,000 cfs, because the intake of the diversion tunnel to the power house is located on the floor of Copco No. 2 Reservoir, regular scour along the thalweg would occur, limiting any potential sediment deposits to calm areas along the channel margins and areas nearest the dam face.

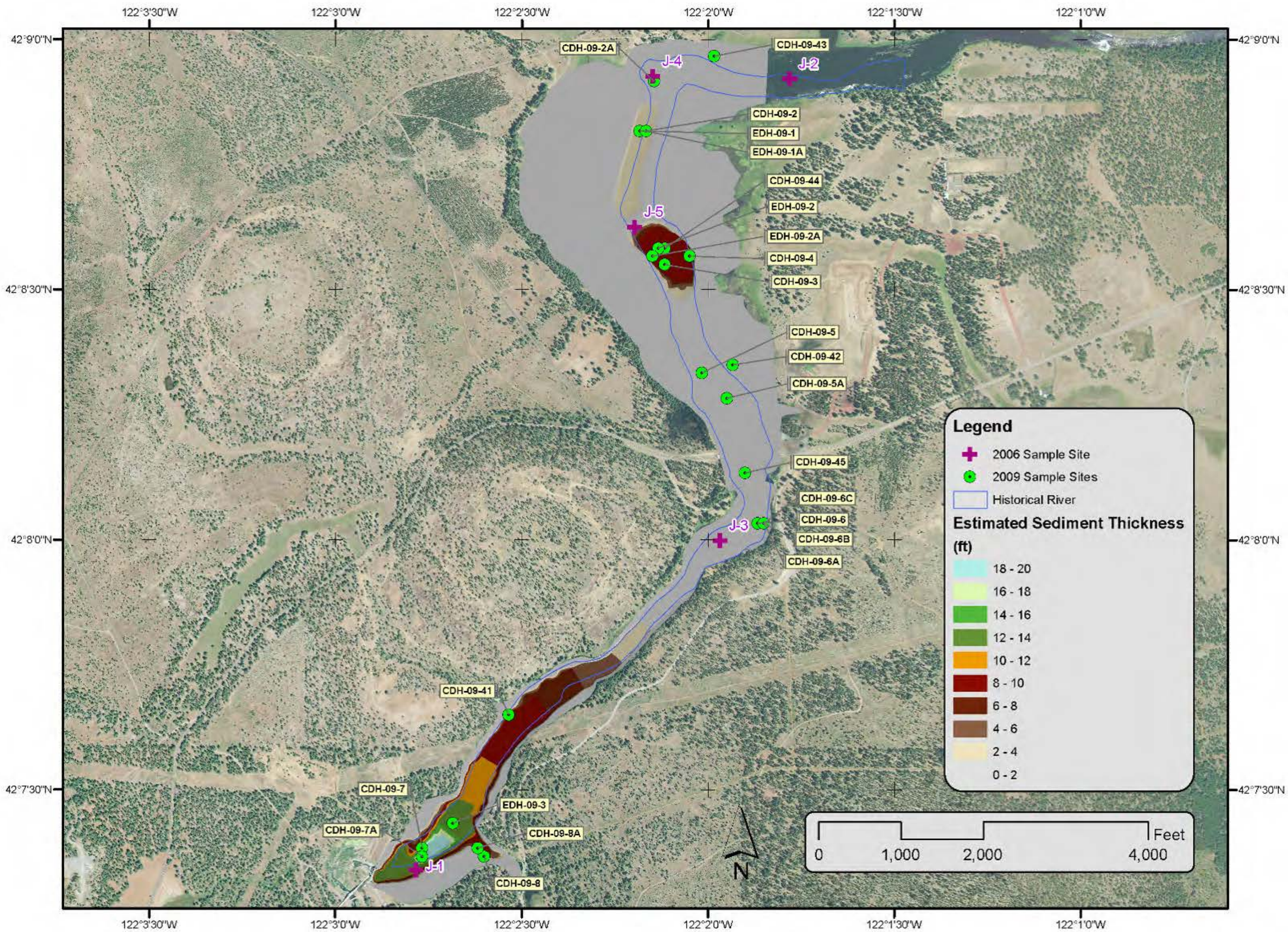

Figure 2.7-7. J.C. Boyle Reservoir Estimated Average Sediment Thickness and Sample Site Locations.

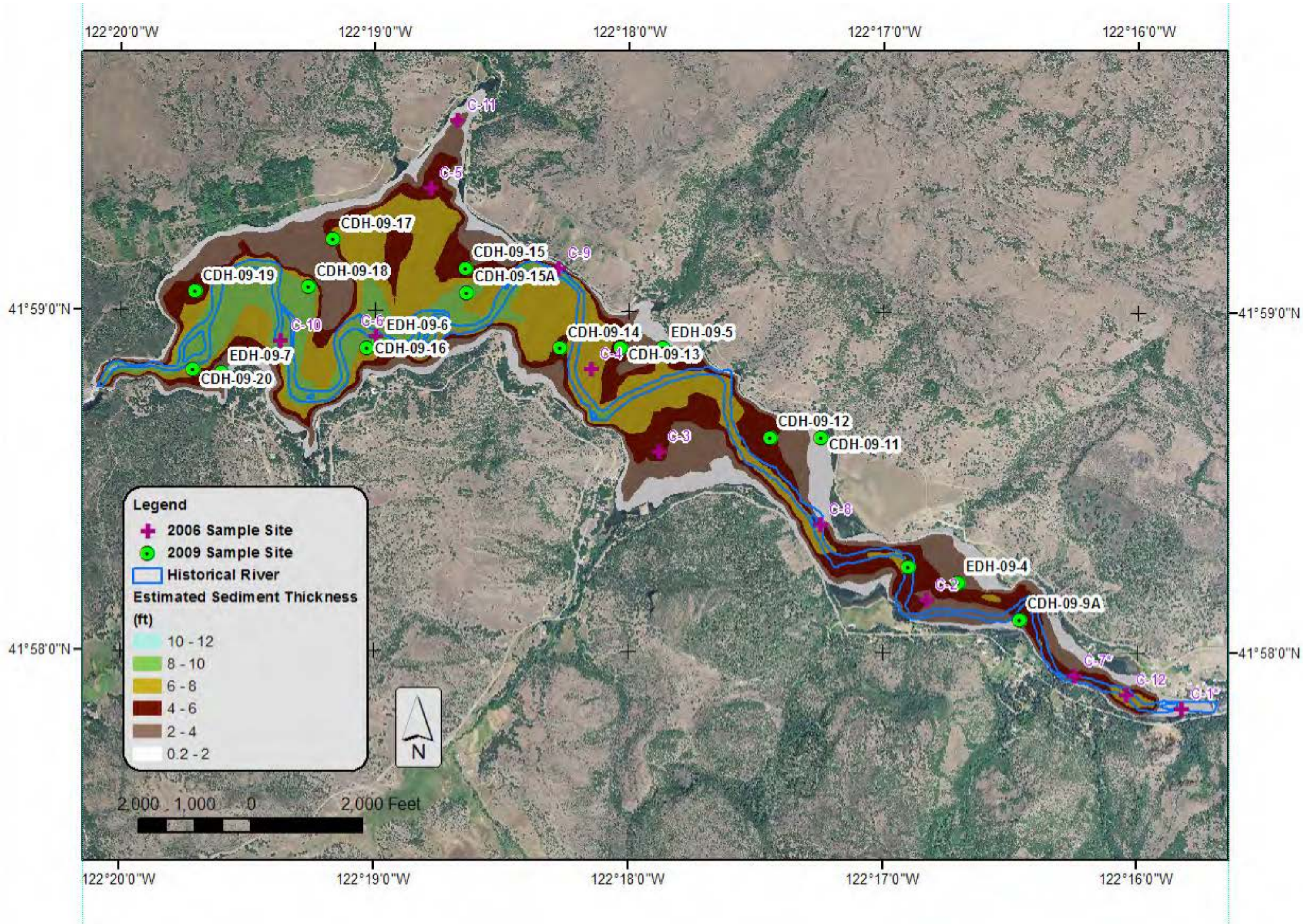

Figure 2.7-8. Copco Reservoir Estimated Average Sediment Thickness and Sample Site Locations.

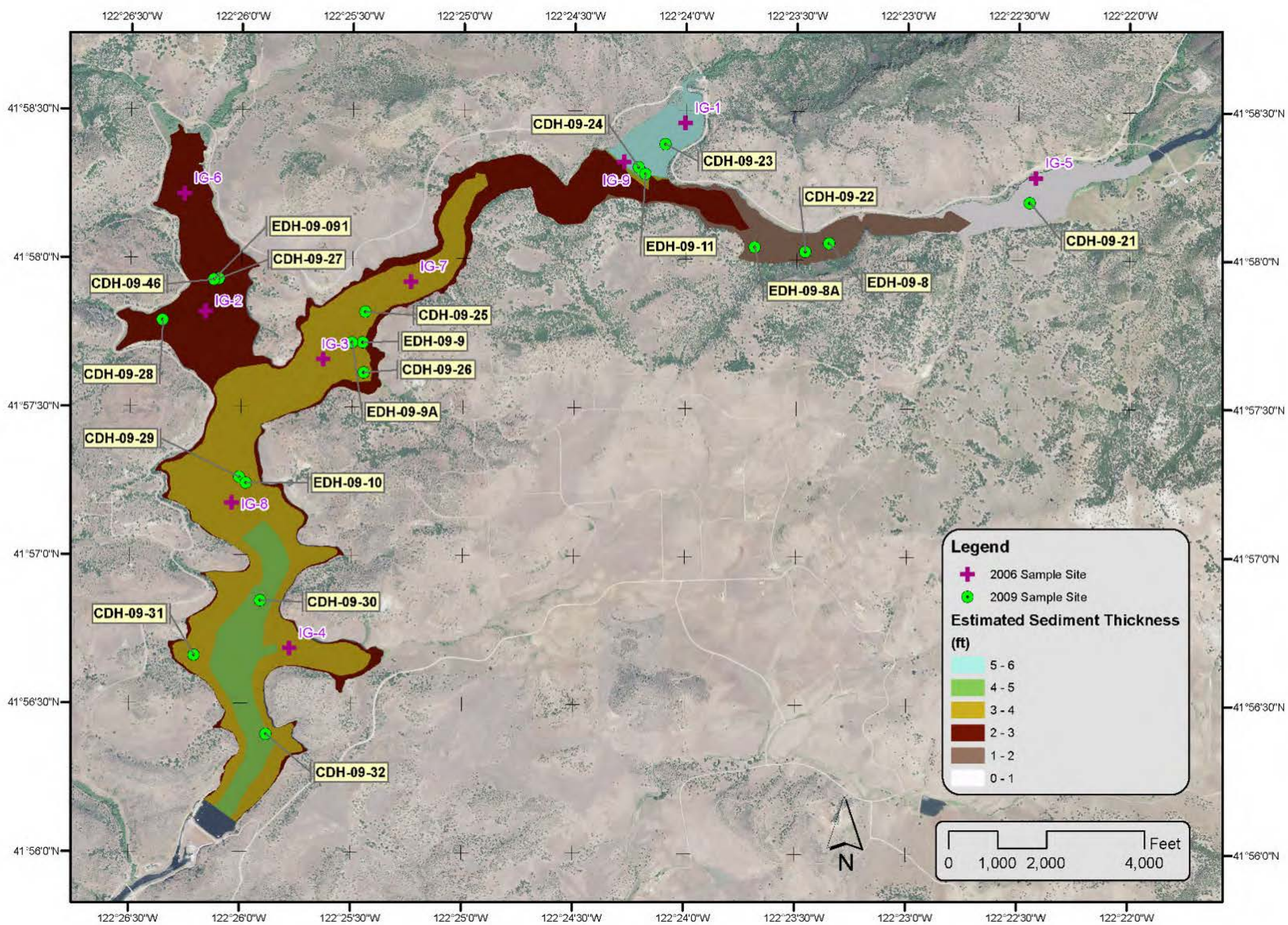

Figure 2.7-9. Iron Gate Reservoir Estimated Average Sediment Thickness and Sample Site Locations.

The current volume and weight of sediment for each reservoir is presented in Table 2.7-9. The uncertainty in the sediment volume estimates is due to interpolation between the 28 to 31 drill holes in each reservoir (USBR 2012a). While the uncertainty in the sediment volume estimate is noticeable, the analysis of sediment erosion potential for the reservoirs is not sensitive to the degree of uncertainty in the volume estimates. Whether the actual reservoir sediment volumes are on the higher end or the lower end of the uncertainty estimate, the dam removal approach and the significance of potential impacts due to sediment transport during reservoir drawdown would remain the same. Sediments as they are deposited in the reservoirs are generally presented in terms of volume, since the sediment volume was measured by the sediment cores taken in each reservoir. However, sediments are typically discussed in terms of mass once they are transported from the reservoir footprints, since the sediment mass would remain constant.

Based on estimated annual sediment deposition rates, an approximately 15.13 million cubic yards (4.16 million tons [dry weight][11]) of sediment would be present behind the dams by 2020[12] (USBR 2012b) (Table 2.7-10). Because the trapped sediments consist primarily of organic material (e.g., dead algae), silts, and clays, they would be easily eroded and flushed out of the reservoirs into the Klamath River, and would continue to be suspended in the river downstream to the Pacific Ocean. Two-dimensional sediment transport modeling of Copco No. 1 Reservoir during drawdown indicates sediments are mobilized from across the reservoir footprint, but the sediments in the historical Klamath River channel would be most likely to erode (USBR 2012b). Coarser reservoir sediment is primarily sand with negligible amounts of larger sediment sizes (i.e., gravel or cobble) which would be transported more slowly depending on the hydrologic conditions. Coarser sediment from dam removal would be expected to primarily deposit between the reservoirs and the confluence of the Klamath River and the Shasta River with an insignificant effect on the streambed downstream of the Shasta River (USBR 2012b).

During drawdown, erosion and transport of sediments deposited within the Copco No. 1 and Iron Gate reservoir footprints would be supported by using barge-mounted pressure sprayers to jet water onto newly exposed reservoir-deposited sediments as the water level decreases, a process called sediment jetting. Sediment jetting would increase the erosion of reservoir-deposited sediments on the historical floodplain areas, especially the historical two-year floodplain, during drawdown and in order to reduce the potential for reservoir sediment erosion outside of the reservoir drawdown period. Additionally, removal of reservoir-deposited sediments with sediment jetting would promote riparian bank and floodplain connectivity by increasing river inundation on the historical floodplain during high flow events and is intended to reduce manual excavation and grading of sediments from proposed restoration sites after drawdown completes. Sediment jetting would be focused in the six areas where restoration actions are proposed within the Copco No. 1 Reservoir footprint (Figure 2.7-11) and the three areas

[11] Ton, dry weight is defined as equal to 2,000 pounds.

[12] Since submitting the original application, KRRC has revised its projection for the year of primary drawdown to be 2021, rather than 2020. Between 2020 and 2021, the sediment volume present behind the dams is expected to increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012b). The expected increase in sediment volume between 2020 and 2021 is an order of magnitude less than the range of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable to the Proposed Project.

where restoration actions are proposed within the Iron Gate Reservoir footprint (Figure 2.7-12).

While the anticipated amount of sediment to be eroded varies somewhat by reservoir, during reservoir drawdown approximately 36 to 57 percent of the total 2020 volume across J.C. Boyle, Copco No. 1, and Iron Gate reservoirs, or an estimated 5.4 to 8.6 million yd^3 (1.2 to 2.3 million tons [dry weight]) of reservoir sediment, would be eroded and flushed downstream during the drawdown period (Table 2.7-11). Large quantities of sediment would remain in place after dam removal in each of the former reservoir beds, primarily on areas above the active channel. The remaining sediments would consolidate (dry out and decrease in thickness). Studies of the existing sediments in J.C. Boyle Reservoir show an anticipated change in sediment depth of up to 61 percent of original depth (USBR 2012a). A higher degree of shrinkage of the sediment layers is expected for Copco No. 1 and Iron Gate reservoirs due to the increased organic matter content in the sediment deposits of these two downstream reservoirs.

The range in estimated erosion volume in each reservoir is primarily dependent upon whether the prevailing hydrology during reservoir drawdown corresponds to a dry hydrologic year or a wet hydrologic year. The majority of the sediment erosion would occur during the reservoir drawdown process and would be a combination of direct erosion of the sediment by moving water, slumping of the fine sediment along the reservoir sides toward the river, and sediment jetting of some areas of reservoir-deposited sediments during drawdown. In a dry hydrologic year, reservoir pool levels can be drawn down steadily and relatively quickly, resulting in a shorter period of interaction between the flow and sediment deposits, and thus less overall sediment erosion. In a wet hydrologic year, the reservoir pool may experience cycles of drawdown followed by periods of refilling during high flow events, resulting in longer period of interaction between the flow and the sediment deposits, and thus more overall sediment erosion.

The rate of reservoir drawdown would also affect the amount of erosion of the sediment deposit. A faster drawdown rate would reduce the time of interaction between the flow and reservoir sediment deposits, thus reducing the overall amount of sediment erosion, whereas a slower drawdown rate would increase the time of interaction between the flow and reservoir sediment deposits, thus increasing the overall amount of sediment erosion. It is expected that increasing the previously modeled maximum drawdown rate of 2.25 to 3 feet per day (USBR 2012b) to the Proposed Project maximum drawdown rate of 5 feet per day (Appendix B: *Definite Plan – Appendix P*) would slightly decrease the total amount of sediment erosion that occurs during drawdown. The previously modeled maximum drawdown rate would result in 36 to 57 percent of erosion of the sediment deposit from the reservoirs (Table 2.7-11) and increasing the drawdown rate to 5 feet per day would most likely result in an amount of erosion toward the lower end of the estimated range or slightly lower. However, the Proposed Project also includes sediment jetting in some locations in Copco No. 1 and Iron Gate reservoirs, which would tend to push the percent of eroded sediment to the higher end of the range (see discussion in Potential Impact 3.2-3 Although no measurements (bathymetry or sediment grain size) are available for Copco No. 2 reservoir (USBR 2011b), continuous operation of the outlet tunnel located on the reservoir bottom suggests little if any accumulation of sediments arriving from upstream would occur during drawdown operations.

Reservoir sediment field sampling and laboratory testing in 2012 (USBR 2012b) and 2018 (Appendix B: *Definite Plan – Appendix H*) indicates that sediments remaining in the reservoir footprint would strengthen as they dry out, but wetting and drying cycles of unvegetated reservoir sediment would cause the sediment to produce erodible fine particles and aggregates. There is the potential for unvegetated sediments to cause short-term elevated suspended sediment concentrations during fall rain events if not stabilized with vegetation, especially from Iron Gate Reservoir where the highest levels of fine sediment and particles were produced in response to the laboratory wetting and drying cycles. These results are consistent with suspended sediment modeling results (USBR 2012b) indicating that SSCs can periodically increase under storm conditions. Tests of sediment from J.C. Boyle, Copco No. 1, and Iron Gate reservoirs showed that vegetation reduces the production of erodible fine particles during wetting and drying cycles in the Copco No. 1 reservoir sediments.

Additionally, the KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) details restoration activities planned for the reservoir areas during reservoir drawdown including seeding (via ground equipment, barge, or aerial application) and native plantings to further anchor remaining sediments. As the system returns to riverine conditions within the reservoir footprints, erosion and sediment transport rates are anticipated to return to natural background rates for this portion of the watershed (USBR 2012b).

Table 2.7-10. Stored Sediment in the Klamath Hydroelectric Project, Fall 2009.

Reservoir	Total Sediment Volume[1] (yd^3)		Total Sediment Mass[2,3,4] (tons, dry weight)	Fine Sediment Mass[2,4,5] (tons, dry weight)	Sand Sediment Mass[2,4,6] (tons, dry weight)	Percent Fine Sediment by Mass[8]	Percent Sand Sediment by Mass[8]
J.C. Boyle	990,000	+/- 300,000	290,000	190,000	100,000	66 percent	34 percent
Copco No. 1[7]	7,440,000	+/- 1,500,000	1,880,000	1,630,000	260,000	86 percent	14 percent
Iron Gate[7]	4,710,000	+/- 1,300,000	1,430,000	1,210,000	230,000	84 percent	16 percent
Total[7]	13,150,000	+/- 2,000,000	3,600,000	3,020,000[6]	590,000	84 percent	16 percent
Total Copco No. 1 and Iron Gate[7]	**12,150,000**	**+/- 2,000,000**	**3,320,000**	**2,830,000[6]**	**490,000**	**85 percent**	**15 percent**

Source: Modified from USBR 2012a, as noted in the below footnotes.

1 Uncertainty resulted from interpolation between drill holes and is calculated as a volume with a +/- amount shown in the table (USBR 2012a).

2 Amount of sediment with a diameter greater than 2 millimeters is negligible (< 0.5 percent) for all the reservoirs and within the uncertainty of the sediment estimates.

3 Average dry densities vary between reservoirs and within the reservoir depending upon compaction and grain size distribution. The dry unit weight varies between 44.4 and 16.3 lb/ft^3 (USBR 2012a).

4 Ton, dry weight is defined as equal to 2000 pounds.

5 Fine sediment is sediment with a diameter less than 0.063 millimeters.

6 Sand sediment is sediment with a diameter between 0.063 and 2 millimeters.

7 Amounts of sediment (volumes and masses) from individual reservoirs may not equal the total amounts indicated because all volumes and masses taken from USBR (2012a) were rounded to the nearest 10,000 yd^3 (volume) or 10,000 tons, dry weight (mass). Copco No. 2 Reservoir does not retain measurable amounts of sediment and therefore is not included in the estimates of total stored sediment.

8 Percent sediments are calculated from the masses listed in the table and rounded so the percent fine sediment and the percent sand sediment sum to 100 percent.

Table 2.7-11. Estimated Amount of Sediment in the Lower Klamath Project Reservoirs in 2020.

Reservoir	Estimated 2020 Total[1]			
	Total Sediment Volume (yd^3)	Total Sediment Mass[2,3] (tons, dry weight)	Fine Sediment Mass[3,4] (tons, dry weight)	Sand Sediment Mass[3,5] (tons, dry weight)
J.C. Boyle	1,190,000	340,000	220,000	120,000
Copco No. 1	8,250,000	2,090,000	1,800,000	290,000
Iron Gate	5,690,000	1,730,000	1,460,000	280,000
Total[6]	**15,130,000**	**4,160,000**	**3,480,000**	**680,000[4]**
Total Copco No. 1 and Iron Gate[6]	**13,940,000**	**3,820,000**	**3,260,000**	**560,000[4]**

Source: Modified from USBR 2012a, as noted in the below footnotes.

1 Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012b). The increase in sediment volume between 2020 and 2021 be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable to the Proposed Project.

2 Amount of sediment with a diameter greater than 2 millimeters is negligible (< 0.5 percent) for all the reservoirs and within the uncertainty of the sediment estimates.

3 Ton, dry weight is defined as equal to 2000 pounds.

4 Fine sediment is sediment with a diameter less than 0.063 millimeters.

5 Sand sediment is sediment with a diameter between 0.063 and 2 millimeters.

6 Amounts of sediment (volumes and masses) from individual reservoirs may not equal the total amounts indicated because all volumes and masses taken from USBR (2012a) were rounded to the nearest 10,000 yd^3 (volume) or 10,000 tons, dry weight (mass). Copco No. 2 Reservoir does not retain measurable amounts of sediment and therefore is not included in the estimates of total stored sediment.

Table 2.7-12. Estimated Amount of Sediment Anticipated to Erode with Dam Removal.

Reservoir[1]	Percent Erosion[2]		Fine Sediment Mass[3,4,5] Erosion		Sand Sediment Mass[3,4,6] Erosion	
	Minimum Erosion (percent)	Maximum Erosion (percent)	Minimum (tons, dry weight)	Maximum (tons, dry weight)	Minimum (tons, dry weight)	Maximum (tons, dry weight)
J.C. Boyle	27 percent	51 percent	60,000	110,000	30,000	60,000
Copco No. 1	45 percent	76 percent	820,000	1,370,000	130,000	220,000
Iron Gate	24 percent	32 percent	350,000	460,000	70,000	90,000
Total[4]	36 percent	57 percent	1,230,000	1,950,000	230,000	370,000
Total Copco No. 1 and Iron Gate[4]	36 percent	56 percent	1,170,000	1,830,000	200,000	300,000

Source: Modified from USBR 2012a, as noted in the below footnotes.

1 Amount of sediment with a diameter greater than 2 millimeters is negligible (< 0.5 percent) for all the reservoirs and within the uncertainty of the sediment estimates.

2 Erosion would primarily occur during the drawdown period. The erosion rates are based on hydrologic conditions recorded for the March to June flow volume at Keno gage on the Klamath River from water year 2001 (90 percent exceedance) and 1984 (10 percent exceedance). Additional erosion and sediment transport could occur in the following year that would be indistinguishable from the background sediment regime.

3 Ton, dry weight is defined as defined as equal to 2,000 pounds.

4 Estimated amount of sediment mass eroded with dam removal based on estimated sediment amount in the reservoirs in 2020. Amounts of sediment masses from individual reservoirs may not equal the total amounts indicated because masses taken from USBR (2012a) were rounded to the nearest 10,000 tons, dry weight (mass). Copco No. 2 Reservoir does not retain measurable amounts of sediment and therefore is not included in the estimates of sediment anticipated to erode with dam removal.

5 Fine sediment is sediment with a diameter less than 0.063 millimeters

6 Sand sediment is sediment with a diameter between 0.063 and 2 millimeters.

2.7.4 Restoration Within the Reservoir Footprint

The KRRC's Proposed Project includes establishing native vegetation within the reservoir footprints to stabilize newly exposed reservoir sediments and support a functioning ecosystem. Additional information on planned restoration efforts during and following dam removal can be found in the KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan − Appendix H*).

2.7.4.1 Revegetation Activities

The following sequence describes the activities that would be implemented in the former reservoir footprints to manage remaining sediment deposits and restore habitats. Pre-dam removal restoration activities (i.e., one to two years before drawdown) would occur on the upland areas outside of the reservoir footprints; accordingly, these activities are discussed below in Section 2.7.5 *Restoration of Upland Areas Outside of the Reservoir Footprint*. See additional detail in KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan − Appendix H*).

1. *Pre-dam Removal* (pre-dam removal year 3, and dam removal year 1): collect and propagate seed and control invasive plants.

2. Reservoir drawdown (January to March, dam removal year 2): amend sediment as necessary and stabilize sediments and exposed areas with hydroseeding13. To stabilize remaining reservoir sediment, the newly exposed reservoir areas would be revegetated during and following reservoir drawdown with native species through pioneer hydroseeding (via ground equipment, barge, or aerial application). Acorns, shrub seedlings, and pole cuttings would be installed early, as feasible.
3. Post-drawdown first summer/fall (dry season immediately after drawdown during dam removal year 2): monitor and rectify any non-natural fish passage barriers in the Klamath River's mainstem and tributaries, conduct additional fall overseeding application (overseeding application would involve a ground-based broadcast seeder, to be applied over mowed or rolled vegetation that grows in from the pioneer seeding) where needed on exposed reservoir areas, manual removal/treatment of invasive exotic vegetation, and installation of riparian trees and shrubs. Irrigation would be installed in the Riparian Bank Zone to support survival of planted riparian species. Plants below this zone would obtain water from the river and irrigation runoff. For plants above the Riparian Bank Zone, seedlings would be provided water by planting the seedling in a 'cocoon' which is a donut shaped container that surrounds the seedling and is made out of biodegradable paper mâché. If initial restoration efforts are unsuccessful in the upland areas, a temporary irrigation system would be installed. Riparian pole cuttings and other wetland plants would be harvested from on-site areas that would no longer support riparian species
4. Post-removal (post-dam removal year 1): maintain vegetation, continue to remove and treat invasive exotic vegetation, install floodplain and off-channel habitat features such as large wood to enhance complexity and stabilize banks or bury brush, limbs and wood to roughen the floodplain to enhance establishment of vegetation and organic materials. Monitor and rectify any non-natural fish passage barriers in mainstem and tributaries.
5. Establishment period (post-dam removal years 2 through 5): continued monitoring and maintenance of vegetation, removal of invasive exotic vegetation, fish passage monitoring, and enhancement of habitat features as needed.
6. Long term (years 5 through 10 post-dam removal): continued monitoring and adaptive management, removal of invasive exotic vegetation, and fish passage monitoring.

KRRC proposes to restore the former reservoir footprints with native plant species, trees and shrubs. The natives would be planted in upland, riparian, and wetland zones. To facilitate the restoration of this area and growth of planted vegetation, about 34.5 miles of permanent cattle exclusion fencing would be installed around the reservoir areas (Appendix B: *Definite Plan – Appendix H*) prior to drawdown or shortly after the pioneer seeding. It is unknown if this fencing would remain following the transfer of Parcel B

[13] Although not currently anticipated by KRRC, the Proposed Project may also include hydroseeding from a barge on exposed reservoir terraces as the water recedes during reservoir drawdown. Hydroseeding from a barge would be accomplished by placing a ground rig on one barge with another boat used to ferry materials from shore. A moveable pier or other engineered method of accessing the supply boat as the water level recedes would also be needed. If it occurs, barge hydroseeding would occur in the higher elevation portion of the reservoir shoreline, until the reservoir levels become too low to operate (i.e., March of dam removal year 2).

lands. Cattle currently free-range around reservoirs, and the purpose of cattle exclusion fencing is to prevent cattle from grazing on newly restored vegetation. The fencing would be wildlife-friendly and allow for the movement of deer, turtles, etc., while preventing access of cattle. Herbivore deterrent (e.g., screens, fencing, chemical deterrents) would be placed around planted riparian vegetation.

Proposed native seed mixes and plants along with information on the goals and objectives associated with the restoration activities are provided in KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan − Appendix H*). The management techniques for invasive exotic vegetation (IEV) may include manual weed extraction, solarization (covering of ground areas with black visqueen), tilling, and use of herbicides. See additional detail in KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan − Appendix H).* In order to effectively eradicate IEV in the Limits of Work to the extent feasible and prevent the spread of IEV into restoration areas, KRRC would begin active control of IEV several years before drawdown and would continue until the required performance criteria are met. The KRRC began IEV surveys in fall 2017, between the existing water line and the boundary of the Limits of Work, to obtain information on the exact location of each invasive species and information on the diversity of invasive species. The results would be the basis for the IEV removal plan which would be initiated prior to drawdown.

The Proposed Project Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) incorporates monitoring and metrics to evaluate success of minimizing invasive exotic vegetation and enhancing native plant diversity and survival of planted trees and shrubs. Monitoring would continue for five years or until the performance criteria has been met. In the event the performance criteria are not being met, the cause would be evaluated, data collection and performance criteria metrics would be reassessed as necessary, and the KRRC would develop a plan to address problems and initiate further monitoring. The performance criteria are the following:

- Minimize invasive exotic vegetation—percent relative cover by medium and low priority IEV shall be less than the average at designated reference locations at Year 1—25 percent, Year 2—40 percent, Year 3—55 percent, Year 4—70 percent, Year 5—90 percent, and no high-priority invasive plants present in the Limits of Work;
- Enhance native plant diversity—percent diversity compared to reference sites in Year 1—60 percent, Year 2—65 percent, Year 3—70 percent, Year 4—75 percent, and Year 5—80 percent; and
- Survival of planted trees and shrubs—percent survival in Year 1—90 percent, Year 2—85 percent, Year 3—80 percent, Year 4—75 percent, and Year 5—70 percent.

2.7.4.2 Reservoir Restoration Features

Proposed restoration activities for the reservoir footprints are supporting reservoir-deposited sediment evacuation; enhancing tributary connectivity to the Klamath River; incorporating floodplain features such as wetlands, swales, and side channels; enhancing floodplain roughness to stabilize vegetation; and stabilizing banks and enhancing channel complexity, often with the use of large wood (Figure 2.7-10).

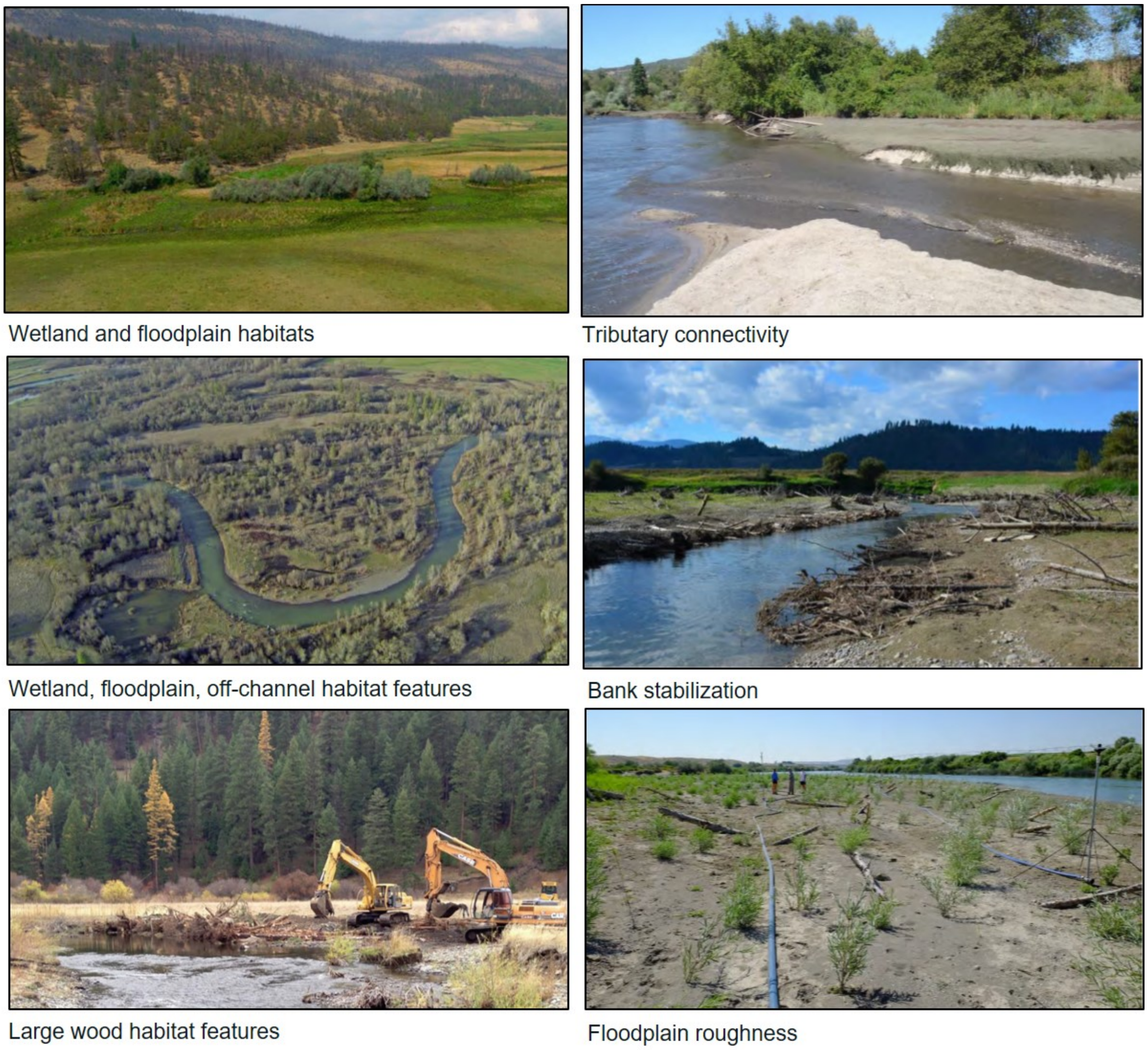

Figure 2.7-10. Examples of Restored Habitat Types and Components (Appendix B: *Definite Plan – Appendix H*).

During drawdown, a barge-mounted pressure sprayer would jet water onto newly exposed reservoir-deposited sediments (this process is called sediment jetting) as the reservoir water level decreases to support transport of reservoir-deposited sediments from the historical floodplain. The erosion of reservoir sediments from the historical floodplain, especially the two-year floodplain, would promote riparian bank and floodplain connectivity for restoration features by increasing river inundation on the floodplain during high flow events. Sediment jetting would also prepare areas for restoration by minimizing the necessary manual excavation and grading of sediments at those sites. Sediment jetting would be focused in the six areas where restoration actions are proposed within the Copco No. 1 Reservoir footprint (Figure 2.7-11) and the three areas where restoration actions are proposed within the Iron Gate Reservoir footprint (Figure 2.7-12). During the drawdown period between January and April of dam removal year 2, additional manual grading and transport of reservoir-deposited sediment would occur in proposed restoration areas near existing roads with easy access for machinery, such as bulldozers and excavators.

During and following reservoir drawdown, tributaries would flow over the area now submerged by the reservoirs toward the new riverbed of the Klamath River. Tributaries would likely transport fine sediment downstream (i.e., it would not deposit in the reservoir footprint), but some larger sediments and debris may deposit and create fish passage barriers or un-natural changes in slope in the tributary flow paths located within the reservoir footprints. KRRC proposes using light equipment and manual labor to move such barriers and enhance access and longitudinal connectivity of the tributaries with the mainstem Klamath River within the reservoir footprints (Figure 2.7-10). In addition, the KRRC may add large wood to tributaries to promote habitat complexity.

Incorporating floodplain features that create natural elevation variations (e.g., swales) into the newly exposed floodplains within the reservoir footprints is a restoration strategy that promotes habitat complexity and function. Based on historical images of the Project area, the KRRC has indicated that the following three main types of features could be supported on the newly exposed floodplain areas:

- Wetlands are low-lying features with standing water or saturated soils for a portion of the growing season sufficient to support wetland vegetation such as willows, sedges, and rushes. Wetlands provide a wide range of ecological functions such as water quality improvement, flood attenuation, and habitat for both terrestrial and aquatic organisms. Wetland restoration strategies for the reservoir areas include preservation of existing wetlands, hydrologic connection of off-channel wetlands with the river, or creation of new wetlands at lower elevations corresponding to the post-dam removal surfaces and hydrologic regime (see Figure 2.7-10).
- Floodplain swales are small depressions where floodplain vegetation can establish at slightly lower elevations (closer to the water table) than adjacent floodplain surfaces. These depressions provide storage for flood water and sediment at variable flows, in addition to broadening the range of ecological niches available on the floodplain surface to support different life stages (and behaviors) of wildlife species.
- Side channels are channels off the main channel that provide habitat for juvenile rearing and high flow refugia for other aquatic species. Like floodplains, side channels exchange water, sediment and nutrients between the main channel and off-channel areas, thus supporting diverse vegetation communities. Side channel restoration strategies are designed to improve instream habitat diversity and include modifying inlet and outlet hydraulics, improving hydraulic complexity with structures or realignment, and delivery of water to higher floodplain surfaces.

To provide a temporary replacement for the lack of established, stable vegetation in the reservoir footprints, the KRRC proposes to use ground-based equipment to ‘roughen’ the floodplain surface and partially bury wood, limbs, or brush in the sediment deposits that remain following drawdown (Figure 2.7-10). The KRRC has indicated that installing these features would create complexity and provide a location for seeds to establish, reduce erosion by reducing velocity, and promote soil development by introducing organic matter (Appendix B: *Definite Plan − Appendix H*).

To stabilize the banks and enhance the complexity of the channel fringe along the newly exposed Klamath River within the reservoir footprints, the KRRC has proposed installation of large wood features (e.g., trees, root wads) and planting of riparian vegetation (Figure 2.7-10) (Appendix B: *Definite Plan − Appendix H*). These features would reduce water velocities creating low velocity zones that would provide habitat for fish and wildlife. Placement of wood features along the river banks would be accomplished using ground-based equipment or helicopters.

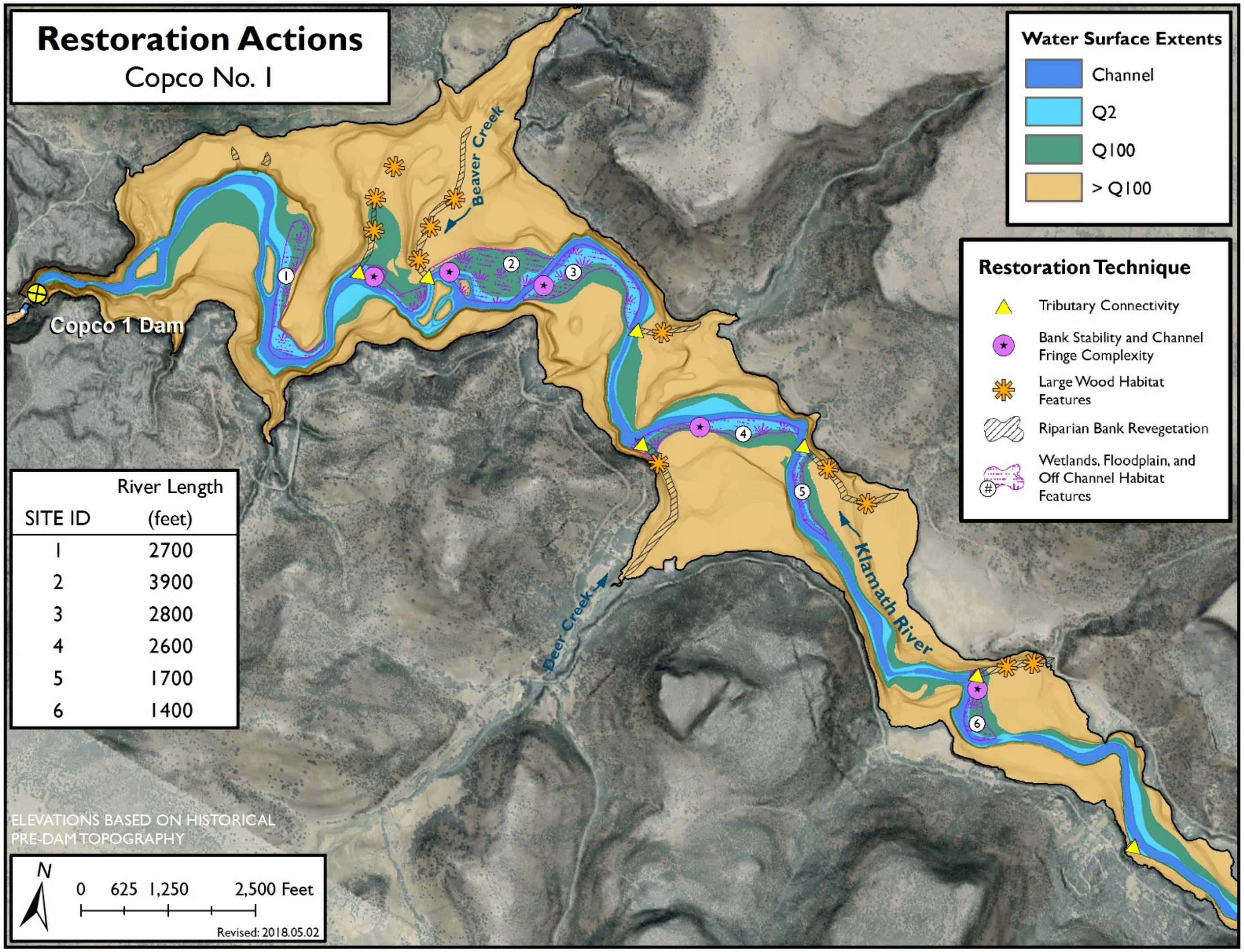

Figure 2.7-11. Restoration Actions Identified for the Copco No. 1 Reservoir Area (Appendix B: *Definite Plan – Appendix H*).

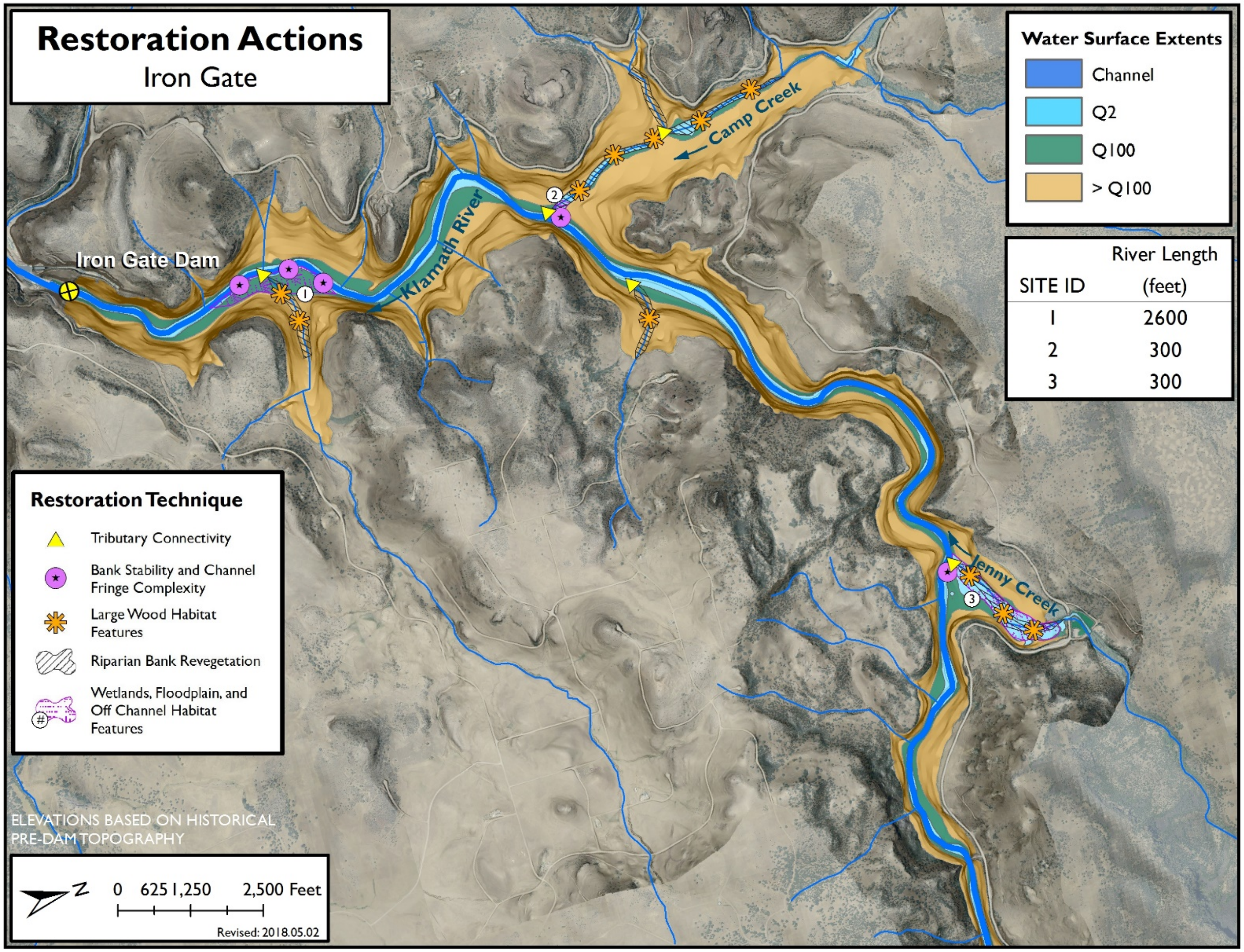

Figure 2.7-12. Restoration actions identified for the Iron Gate Reservoir area (Appendix B: *Definite Plan – Appendix H*).

2.7.5 Restoration of Upland Areas Outside of the Reservoir Footprint

Restoration activities would also occur in Project-affected upland areas surrounding the reservoirs. During the pre-dam removal period, native plants would be prepared for restoration activities by collecting seeds and working with local nurseries to grow trees and shrubs. Active management of invasive exotic vegetation species would be initiated prior to drawdown and would continue until the Proposed Project completion. The management techniques for invasive exotic vegetation may include grazing with cattle, sheep, and goats, manual weed extraction, solarization (covering of ground areas with black visqueen), tilling, and use of herbicides. See additional detail in KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan − Appendix H*).

During the post-dam removal period, restoration would occur in upland areas outside of the reservoir footprints, including disposal areas used for placing embankment or concrete material, staging areas, temporary access roads, hydropower infrastructure demolition areas, and former recreation areas. Revegetation of these areas in the short term would be implemented in compliance with an approved Storm Water Pollution Prevention Plan (SWPPP)/Erosion Control Plan (see also Section 2.7.8.7 *Water Quality Monitoring*). In the long term, these areas would be revegetated similar to the upland planting zone areas, as described in the KRRC's Reservoir Area Management Plan (Appendix B: *Definite Plan − Appendix H*). Since upland soils would be highly compacted, soils would be disked and ripped (a process used to mechanically break up compacted soil layers) to prepare them for subsequent planting.

Existing native vegetation would be preserved and protected where feasible. Native trees within the Limit of Work that do not need to be removed for construction or demolition activities (as determined by KRRC authorized representative) would be retained (S. Leonard, Senior Water Resources Engineer, AECOM, pers. comm., July 2018). These native trees would be protected, to the maximum extent practical, by a work exclusion zone around the trunk with a radius equal to approximately one time the average tree canopy diameter. The work exclusion zone would be visibly demarcated in the field with non-moveable orange fencing, and adjacent protected trees may be fenced together in groupings, as appropriate. For native trees adjacent to construction and demolition activities where work exclusion zone establishment is not possible, large sheets of steel plate (minimum size of 4-foot width, 8-foot-long, 0.5-inch-tall) would be laid on the ground to distribute the potential point loads in order to prevent the crushing of tree roots underground.

2.7.6 Hatchery Operations

2.7.6.1 Iron Gate Hatchery

During demolition, the Iron Gate Hatchery facilities located at the base of Iron Gate Dam, including the adult fish ladder and holding tanks at the toe of the dam, would be removed, as would the cold-water supply and aerator for the hatchery (see also Figure 2.3-4 and Section 2.7.1.4 *Iron Gate Dam and Powerhouse*). Portions of the hatchery located downstream near the confluence of Klamath River and Bogus Creek would remain in place or would be altered, including conversion of two of the existing raceways to adult holding tanks, and construction of a new spawning facility, so limited operations could continue at the facility for eight years following dam removal. Consistent with the KHSA Section 7.6.6, the hatchery would be operated for eight years following the decommissioning[14] of Iron Gate Dam. Given that power generation at Iron Gate Powerhouse is scheduled to cease by January of dam removal year 2 (Table 2.7-1), the hatchery would operate from dam removal year 2 through post-dam removal year 7, for a total of eight years. Following the eight-year period, Iron Gate Hatchery would cease operations. It is currently unclear whether the Iron Gate Hatchery facility would be decommissioned in place, demolished, or partly or fully repurposed after the eight-year operational period.

Some operational components of Iron Gate Hatchery would be retained during dam removal (Figure 2.7-13). The operations during dam removal would include a maximum of 8.75 cfs of water to be diverted from Bogus Creek within 1,000 feet of the confluence with the mainstem Klamath River. This water would operate the Iron Gate Hatchery incubation building, two 300-foot adult holding ponds, three 400-foot raceway, and an auxiliary adult fish ladder and trap (to replace the one removed from the base of Iron Gate Dam during demolition). Iron Gate Hatchery would use between 3.75 and 8.75 cfs from October through May to rear the targeted goal of 3.4 million Chinook smolts for release in April through May of each year. The diversion for the hatchery water supply would be constructed as close to the confluence of Bogus Creek and the Klamath River as possible, in order to reduce the length of Bogus Creek rearing habitat affected by water withdrawals downstream of the diversion. An approximately 4,000 gallons per minute (gpm) screened, pump station would be used to divert water from Bogus Creek. Specific diversion rates from Bogus Creek would be as follows:

- 6.50 cfs October through November
- 8.75 cfs in December
- 3.50 cfs January through March
- 8.25 cfs April through May
- 0.00 cfs June through September

The Bogus Creek water diversion would be operated to maintain a minimum of 50 percent of the instream flow in the creek at the point of diversion. To provide context for the proposed Bogus Creek diversion rates, daily average flow rates of Bogus Creek from August 2013 to August 2017 are compared with the proposed water needs at Iron Gate Hatchery in Figure 2.7-14. In addition, Figure 2.7-14 shows the percent of Bogus Creek flow remaining after subtracting the Iron Gate Hatchery diversion, with a negative percentage indicating that there would not be enough flow in Bogus Creek to meet the Iron Gate Hatchery water needs. Between August 2013 and August 2017, the proposed flow diversions for Iron Gate Hatchery would have consistently diverted more than 50 percent of Bogus Creek flow during part of each year, especially during October, November, April, and May. In spring/early summer of 2014, Bogus Creek flows were insufficient to meet the proposed full water needs of the hatchery. These results may be due to the short duration of the dataset or drought conditions between 2013 and 2017 that may not represent long-term conditions. The KRRC proposes that if Bogus Creek flows are insufficient to meet minimum operational needs while balancing flow requirements in the creek, water reuse (recirculation) from the rearing raceways could be utilized. In addition to recirculation, early release of smolts (i.e., prior to April 1) may occur to reduce water use requirements in the hatchery. The effectiveness of

[14] Decommissioning is defined as PacifiCorp's physical removal from a facility of any equipment and personal property that PacifiCorp determines has salvage value, and physical disconnection of the facility from PacifiCorp's transmission grid (KHSA Section 1.4).

recirculation and early smolt release would be studied to determine whether they could be used to meet minimum operational flow and water temperature needs in the hatchery given annual variations in Bogus Creek flow and water temperature during the early release period.

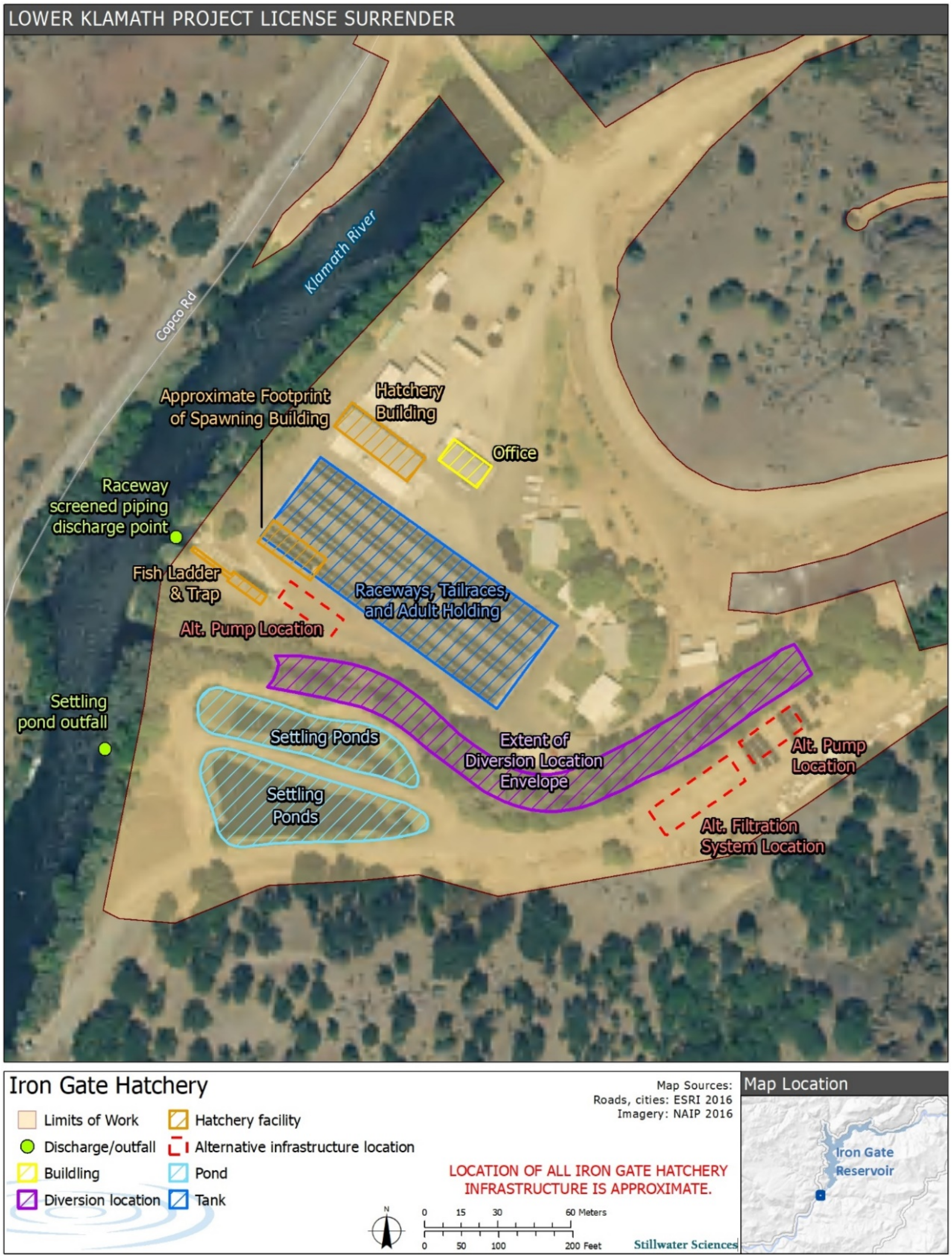

Figure 2.7-13. Iron Gate Hatchery Existing Features and Proposed Modifications.

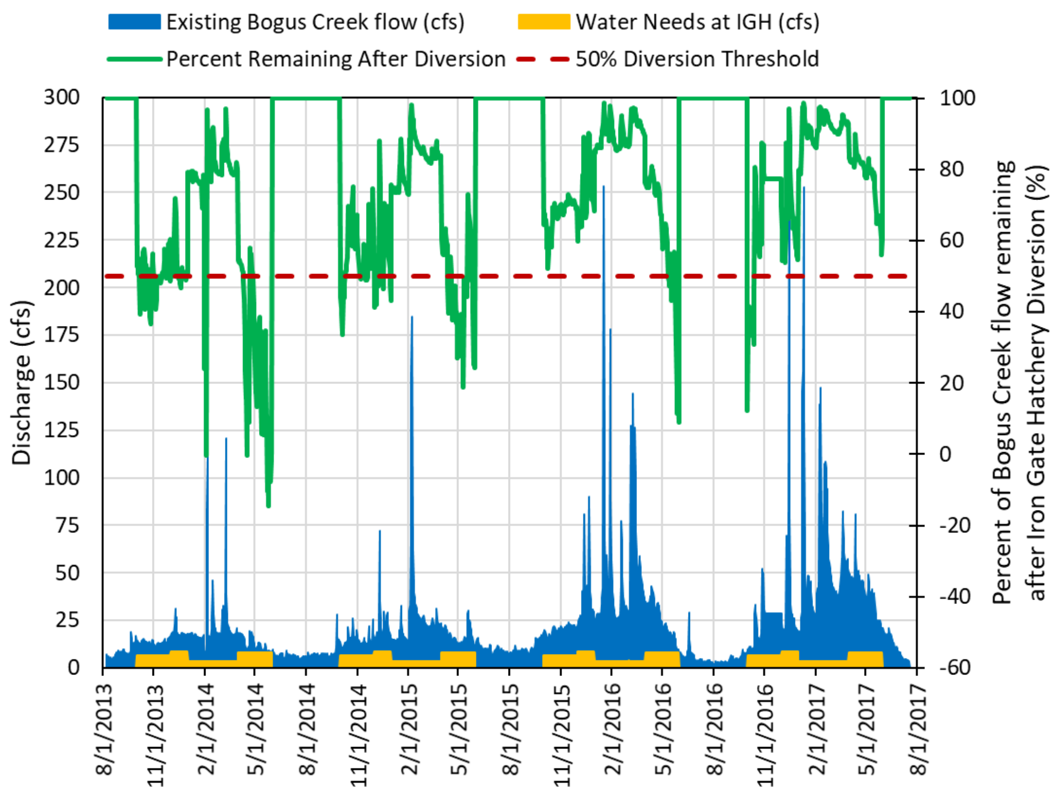

Figure 2.7-14. Bogus Creek Existing Flow and Proposed Flow Diversion to Support Production at Iron Gate Hatchery (ICH) for eight Years Following Dam Removal.

During dam removal year 2 and the subsequent seven years post-dam removal (i.e., eight years total), total hatchery production goals would be reduced from current levels (Table 2.7-13). Iron Gate Hatchery production would be limited to 3,400,000 Chinook salmon smolts, while coho salmon and Chinook salmon yearling production would cease at Iron Gate Hatchery. Steelhead production at the Iron Gate Hatchery has not occurred since 2012, and it would not be re-initiated. Fall Creek Hatchery production (see also Section 2.7.6.2 *Fall Creek Hatchery*) would include 75,000 coho yearlings and 115,000 Chinook yearlings. No Chinook smolts and no steelhead would be produced at Fall Creek Hatchery.

Table 2.7-13. Existing Goals and Proposed Hatchery Production for Operations at Iron Gate and Fall Creek Hatcheries (NMFS and CDFW 2018).

Species/Life Stage	Existing Production Goal[1] (at Iron Gate Hatchery)	Proposed Production (at Iron Gate Hatchery and Fall Creek Hatchery)
Coho Yearlings	75,000	75,000 at Fall Creek Hatchery
Chinook Yearlings	900,000	115,000 at Fall Creek Hatchery
Chinook Smolts	5,100,000	3,400,000 at Iron Gate Hatchery
Steelhead	200,000	0

[1] Ability to meet production goals varies annually based on adult returns and hatchery performance, with coho and Chinook yearling goals achieved on average since 2005 and actual Chinook Smolt production typically a million smolts less than production goals (K. Pomeroy, CDFW, pers. comm., 2018).

2.7.6.2 Fall Creek Hatchery

The KRRC also proposes to reopen the nearby Fall Creek Hatchery, as directed by NMFS and CDFW (2018). The KRRC proposes to reopen Fall Creek Hatchery with upgraded facilities (e.g., install circular tanks, UV treatment system, renovate existing raceways, upgrade plumbing, etc.) for raising coho salmon and Chinook salmon yearlings within the existing facility footprint and an area adjacent to the upper raceways (Figure 2.7-15). Additional space requirements needed for most operations (e.g., vehicle parking, pertinent buildings, tagging trailer, etc.) can be accommodated on existing developed or disturbed areas around the hatchery and powerhouse, but the settling pond would need to be located outside of this area. The settling pond would be constructed on one of two potential nearby sites located on Parcel B lands downstream of the Fall Creek Hatchery, with a minimally buried or at-grade conveyance pipeline transporting flows from the hatchery to the settling pond. Selection of the settling pond site is pending cultural resources investigations and consultation with tribes with historical and cultural connection to the area.

To operate the Fall Creek Hatchery, up to 10 cfs of water would be diverted from the PacifiCorp Fall Creek powerhouse return canal downstream of the City of Yreka's diversion facility at Fall Creek Dam A. Hatchery water would be diverted from Fall Creek Dam B to Dam A during periods when the powerhouse return canal is not flowing. While the Definite Plan specifies diverted water would be returned to Fall Creek at the fish ladder located in the lower tank area or the settling pond location (Appendix B: *Definite Plan −Section 7.8.3*), an October 2018 update specifies the upper rearing tank would discharge diverted water directly to Fall Creek, the lower rearing tank would discharge to the fish ladder adjacent to the tank, and the settling pond would discharge to Fall Creek further down, but upstream of the USGS 11512000 gage on Fall Creek (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., October 2018). Fall Creek diverted water would be gravity fed and plumbed to each rearing location and all circular tanks. Specific diversion rates from Fall Creek would be as follows:

- 8.48 cfs in October
- 9.24 cfs in November
- 6.32 cfs in December
- 5.77 cfs in January
- 1.47 cfs in February
- 1.76 cfs in March
- 1.84 cfs in April
- 1.08 cfs in May
- 0.58 cfs in June
- 1.01 cfs in July
- 1.48 cfs in August
- 2.29 cfs in September

The non-consumptive water diversion for the Fall Creek Hatchery is downstream of the City of Yreka's diversions at Dam A on the PacifiCorp Fall Creek powerhouse return canal. Flows diverted for the hatchery (less evaporative losses) would be returned to

Fall Creek from the three hatchery discharge points (i.e., upper tank, fish ladder near the lower tank, and settling pond) upstream of the compliance point for the City of Yreka diversion, the USGS 11512000 gage on Fall Creek approximately 1,000 feet upstream of Daggett Road (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., October 2018). At the compliance point, the City of Yreka must ensure Fall Creek has a minimum flow of 15.0 cfs, or the natural flow of Fall Creek whenever it is less than 15.0 cfs. To provide context about flows in Fall Creek, the historical daily average City of Yreka water diversion flows from October 2003 to October 2005 along with the historical daily average Fall Creek flows measured at the USGS 11512000 gage during this period are compared with the proposed Fall Creek Hatchery non-consumptive diversion flows in Figure 2.7-16. The proposed Fall Creek Hatchery diversion would not alter Fall Creek flows measured at the USGS 11512000 gage or compliance with minimum Fall Creek flow requirements since the diversion flows for Fall Creek Hatchery would be diverted and returned (less evaporative losses) to Fall Creek upstream of the USGS 1151200 gage under the Proposed Project.

Total hatchery production goals for Fall Creek Hatchery are presented in Table 2.7-13. Following the eight-year period, Fall Creek Hatchery would cease operations. As Fall Creek Hatchery is part of PacifiCorp's Klamath Hydroelectric Project No. 2082, the existing Fall Creek hatchery facilities are subject to the terms of any new FERC action for Project No. 2082. It is currently unclear whether the Fall Creek Hatchery facility would be decommissioned in place, demolished, or partly or fully repurposed after the eight-year operational period.

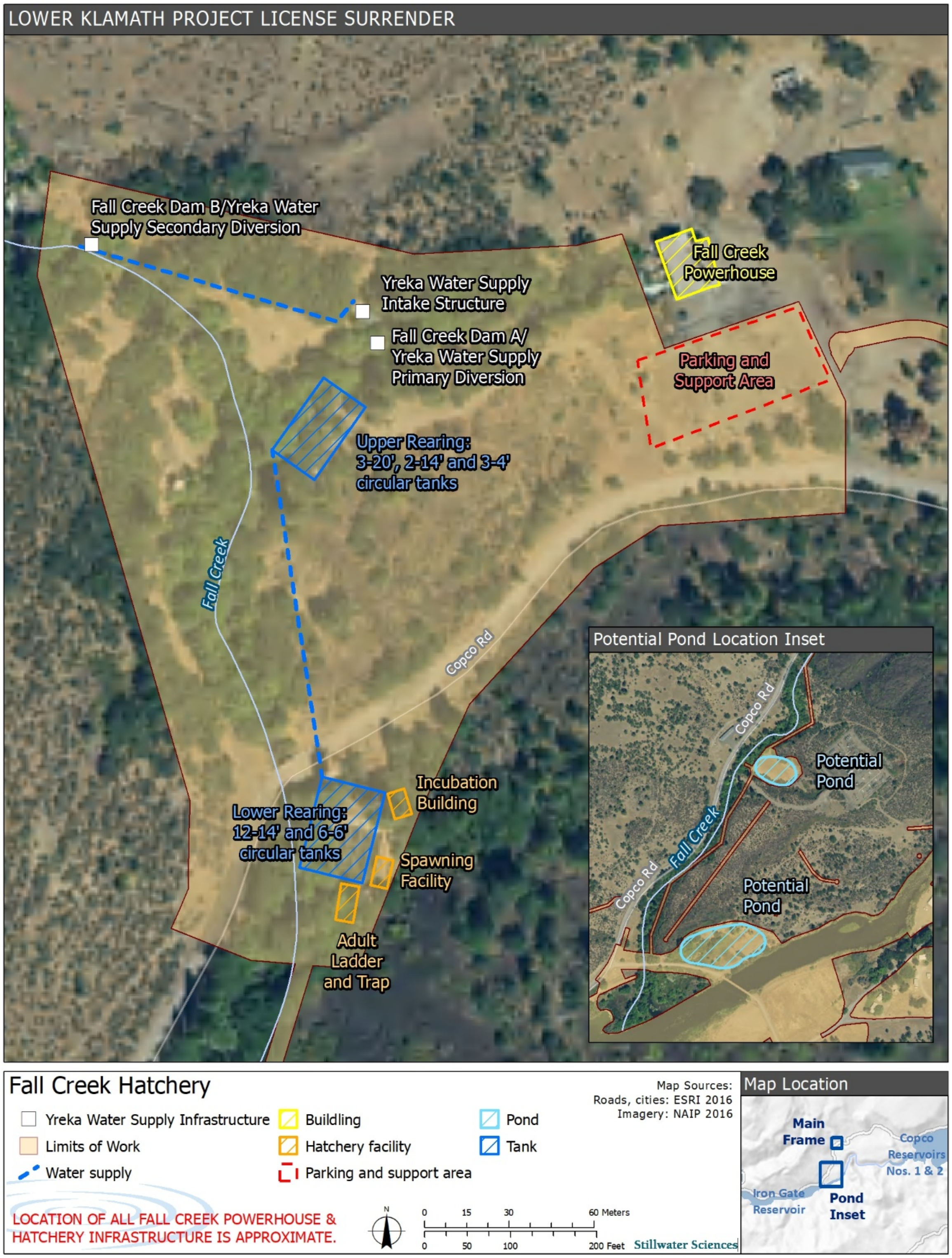

Figure 2.7-15. Fall Creek Hatchery Existing Features and Proposed Modifications.

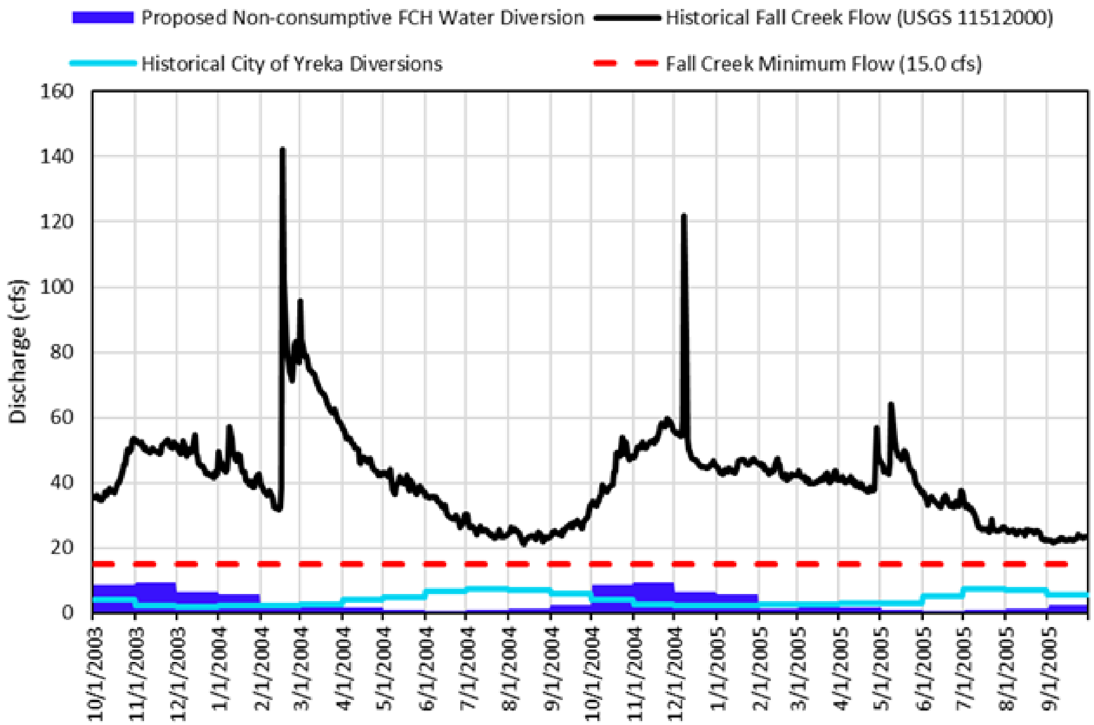

Figure 2.7-16. Proposed Non-consumptive Fall Creek Hatchery (FCH) Water Diversions to Support Production at the Fall Creek Hatchery Following Dam Removal, Historical Fall Creek Flow Measured at USGS 11512000 Downstream of the City of Yreka Diversion, Historical City of Yreka Diversion, and Fall Creek Minimum Flow Requirement (15.0 cfs) Downstream of Compliance Point (USGS 11512000).

2.7.7 City of Yreka Water Supply Pipeline Relocation

The City of Yreka receives part of its water supply from Fall Creek, which is a tributary to the Klamath River in the Upper Klamath Basin. Fall Creek is approximately 23 miles northeast of the city. The city diverts up to 15 cfs of water from Fall Creek through a 24-inch diameter steel pipe near the PacifiCorp's Klamath Hydroelectric Project Fall Creek dam complex. The primary water intake for this water pipeline is located along the PacifiCorp Fall Creek powerhouse return canal at Dam A, which diverts flow to a pumping station further downstream along Fall Creek (Figure 2.7-17). A secondary intake at Dam B on Fall Creek is used when the powerhouse is shut down and supplies water through a pipeline to the intake at Dam A. The pipeline crosses the Klamath River near the upstream end of Iron Gate Reservoir, and it extends to the City of Yreka's water distribution system.

At the upstream end of Iron Gate Reservoir, the pipeline is minimally buried in the reservoir bed (Figure 2.7-17). When Iron Gate dam is removed, the pipe would become exposed to high velocity river flows and would likely sustain damage. A replacement pipe crossing is needed before dam removal and reservoir drawdown to ensure uninterrupted water supply to the City of Yreka.

Additionally, the existing flat panel fish screens for the water supply intakes at Dams A and B may not meet current regulatory agency screen criteria for anadromous fish (USBR 2012a). These fish screens would have to meet the criteria from NMFS, USFWS, and CDFW, and would require updates, if found to be non-compliant.

Conceptual level buried and aerial relocation crossings of the pipeline across the Klamath River have been identified for feasibility and further evaluation. It is desired that any buried crossing should have adequate cover to compensate for the vertical scour during dam removal and the subsequent variations in the river flows and longitudinal profile. As the construction of the relocated crossing needs to happen prior to Iron Gate Dam removal, the cover over the pipe would likely have to exceed 12 feet. An open-cut construction approach would therefore, potentially require significant sediment and rock excavation under water and is not considered as a viable option. Considering this, the KRRC has identified and is proposing one of the following three options for the reconstruction of the Klamath River crossing of the Yreka pipeline:

1. A new buried pipeline by micro-tunneling in the immediate vicinity of the existing waterline crossing.
2. A new aerial pipeline on a dedicated utility pipe crossing in the immediate vicinity of the existing waterline crossing.
3. A new buried pipeline and an aerial pipeline crossing on the existing timber traffic bridge along Daggett Road located approximately 2,000 feet upstream of the existing waterline crossing.

The alignments for the three options are illustrated in Figure 2.7-17 and detailed in Appendix B: *Definite Plan*.

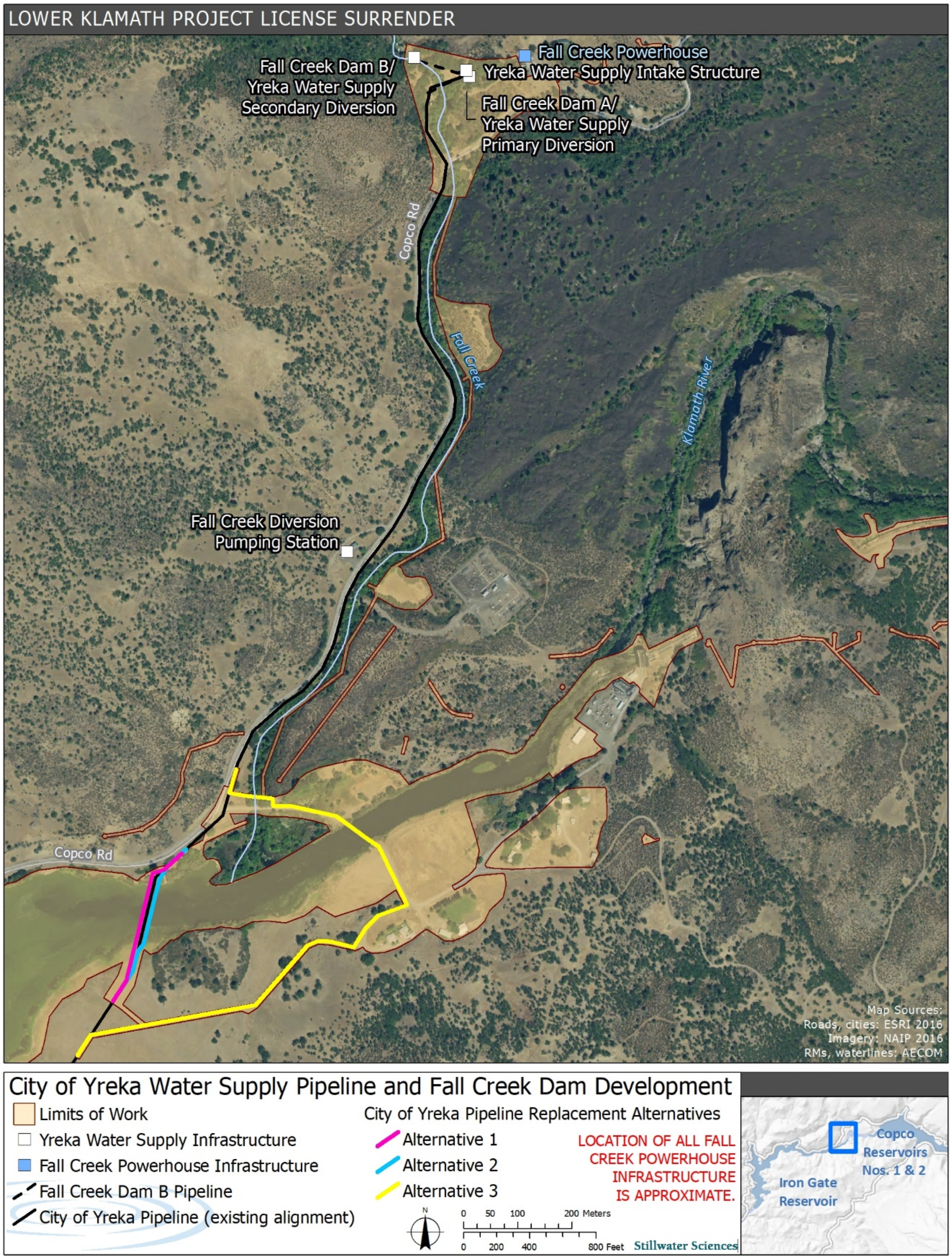

Figure 2.7-17. Alignments for Yreka Waterline Replacement - Klamath River Crossing Conceptual Alternatives.

2.7.8 Other Project Components

There are numerous Proposed Project components identified by the KRRC that fall outside of the major dam and powerhouse deconstruction, reservoir drawdown, reservoir restoration activities, hatchery operations, and City of Yreka water supply pipeline relocation activities described above. The KRRC has proposed these actions to address environmental, safety, and quality of life issues in relation to the major actions discussed above. These other project components summarized in Table 2.7-13 and discussed briefly below. Additional information, regarding these other project components are presented in the individual resource sections (see Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures*).

Table 2.7-14. Summary of Other Project Components.

Project Component		Summary Description	Location in Appendix B
Aquatic Resource Measures	Mainstem spawning	Surveys and protection measures	Definite Plan − Section 7.2 and Appendix I, including 2018 update
	Outmigrating juveniles		
	Iron Gate Fish Hatchery	Delayed release of hatchery fish to avoid poor water quality	
	Suckers	Surveys and relocation	
	Freshwater mussels	Surveys and relocation	
Terrestrial Resource Measures	Habitat restoration	Stabilization of remaining sediments and restoration of reservoir and other disturbed areas	Definite Plan − Section 7.3 and Appendix J
	Nesting birds	Surveys and avoidance and minimization measures	
	Bald and golden eagles		
	Special-status bats		
	Northern spotted owl		
	Special-status plants		
	Wetlands	Delineation, avoidance measures and restoration plan to result in no net loss	
Transportation	Construction access	Improve roads, bridges and culverts affected by the Proposed Project	Definite Plan − Section 7.4 and Appendix K
	Ongoing and post-project maintenance		

Project Component		Summary Description	Location in Appendix B
Recreation Facilities Management/ Recreation Plan	J.C. Boyle Reservoir	Removal of numerous existing recreation facilities, and restoration with native vegetation before, during, and after dam removal; initiates process to add new river-based recreation opportunities	Definite Plan − Section 7.6
	Copco No. 1 Reservoir		
	Iron Gate Reservoir		
	Dispersed Recreation Sites		
Downstream Flood Control		Maintain existing flood protection	Definite Plan − Section 7.7
Cultural Resources Plan		Framework for compliance with cultural resources protection laws	Definite Plan − Section 7.9
Traffic Management Plan		Framework and initial requirements, final plan to be developed by contractor	Definite Plan − Appendix O2
Water Quality Monitoring Plan		Water quality monitoring and analysis to support adaptive management	Definite Plan – Appendix M
Groundwater Well Management Plan		Well monitoring and return production rates of all affected groundwater wells to their pre-dam-removal condition, as necessary	Definite Plan – Appendix N
Fire Management Plan		Framework and initial requirements; final plan to be developed by contractors	Definite Plan – Appendix O1
Hazardous Material Management Plan		Framework and initial requirements; Phase 1 assessment in 2018	Definite Plan – Appendix O3
Emergency Response Plan		Framework and initial requirements; final plan to be developed by contractor	Definite Plan – Appendix O4
Noise and Vibration Control Plan		Framework and initial requirements; final plan to be developed by contractor	Definite Plan – Appendix O5

2.7.8.1 Aquatic Resource Measures

As noted above in Section 2.7 *Proposed Project*, the timing of reservoir drawdown activities was chosen to reduce impacts on anadromous fish species in the Klamath River. Additionally, the Proposed Project includes the aquatic resource (AR) measures summarized below. These measures reflect consultation with a group of fisheries scientists with established regional expertise that KRRC convened to review aquatic resources impact from the proposed project, with particular emphasis on reviewing the resources protection measures proposed in the 2012 KHSA EIS/EIR in light of new information. The ongoing feedback from the group would be used to refine and finalize the plans proposed in the AR measures. Appendix B: *Definite Plan − Appendix I* contains additional detail on background, the latest science, and proposed measures. These measures are subject to further consultation with aquatic resource agencies and the final Biological Opinions for the Proposed Project.

Mainstem Spawning (AR-1)

Short-term effects of dam removal (suspended sediment concentrations and bedload) are anticipated to result in high mortality of embryos and pre-emergent life stages of any fish species spawning in the mainstem Klamath River downstream of Iron Gate Dam during the drawdown year.

The Aquatic Resource Measure AR-1 proposes the development and implementation of a monitoring and adaptive management plan prepared with input from fishery experts to offset the impacts of sediment releases during Lower Klamath Project dam removal on mainstem spawning. The plan would include a 2-year tributary confluence monitoring effort following dam removal and active removal of potential sediment and debris obstructions related to dam removal to improve volitional upstream passage for adult fish species from the Klamath River into its tributaries (thus reducing spawning in mainstem habitat). Monitoring frequency would be variable based on the season and year.

Additionally, any 5-year flow event (estimated as > 10,895 cfs at the USGS gage no. 11516530) within the first two years following reservoir drawdown, would trigger a monitoring effort. AR-1 also includes a proposed spawning habitat evaluation on the Klamath River and its tributaries in the Hydroelectric Reach. If existing spawning habitat conditions for Chinook salmon and steelhead do not meet target metrics described in Appendix B: *Definite Plan – Appendix I*, spawning gravel augmentation would be completed on both the mainstem and key tributaries in the Hydroelectric Reach to offset impacts of Lower Klamath Project dam removal.

Outmigrating Juveniles (AR-2)

Short-term effects of dam removal (suspended sediment concentrations and bedload) are anticipated to result in mostly sublethal[15], and in some cases lethal impacts to a portion of the juvenile Chinook salmon, coho salmon, steelhead, and Pacific lamprey that are outmigrating from tributary streams to the Klamath River upstream of Trinity River (RM 43.3) during late winter and early spring of dam removal year 2.

The Aquatic Resource Measure AR-2 proposes three primary actions to reduce impacts to outmigrating juvenile fish: (1) salvaging mainstem overwintering juvenile salmonids prior to reservoir drawdown; (2) maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River (in conjunction with AR-1 efforts); and (3) developing a water quality monitoring network, trigger thresholds, and plan for salvaging and relocating juvenile fish from tributary confluence areas to cool water tributaries or nearby off-channel ponds. Details on the monitoring and adaptive management actions are provided in Appendix B: *Definite Plan – Appendix I*.

Iron Gate Fish Hatchery Management (AR-4)[16]

Hatchery produced coho salmon smolts that are released into the Klamath River during dam removal year 2, could suffer high mortality if released during periods of high suspended sediment levels (Chinook salmon and steelhead, if any, are typically released during period that are not predicted to coincide with high suspended sediment levels).

[15] Impacts on fish that may cause a behavioral response or physiological damage, without causing direct mortality.

[16] Please note that there is no proposal submitted for an AR-3. The numbering in the EIR follows that in Appendix B: *Definite Plan – Appendix I.*

Aquatic Resource Measure AR-4 proposes that hatchery-reared yearling coho salmon to be released in the spring of dam removal year 2 be held at hatchery facilities until water quality conditions in the mainstem Klamath River improve to sublethal levels. Water quality monitoring stations would be used to determine when conditions in the mainstem Klamath River are suitable. Based on suspended sediment level predictions, a delay of approximately two weeks until mid-May for release of coho salmon smolts is anticipated.

Suckers (AR-6)[17]

Short-term effects of Lower Klamath Project dam removal are anticipated to result in mostly sublethal, and in some cases lethal impacts to Lost River and shortnose suckers within Hydroelectric Reach reservoirs. Lost River and shortnose suckers are lake-type suckers and are therefore not anticipated to persist in the Klamath River following restoration of the Hydroelectric Reach reservoirs to free-flowing riverine conditions.

The Aquatic Resource Measure AR-6 proposes two primary actions to reduce the effect on suckers. The first proposed action is to sample for suckers in the Klamath River and in Hydroelectric Reach reservoirs to document the population's abundance and genetics prior to Lower Klamath Project removal. The second proposed action is to capture as many suckers as feasible (not to exceed 3,000 fish) from within the Klamath River and in Hydroelectric Reach reservoirs and place them into the isolated waterbody of Tule Lake (to ensure hybridized suckers do not mix with sucker populations designated as recovery populations in Upper Klamath Lake). Additional detail is provided in Appendix B: *Definite Plan – Appendix I*.

Freshwater Mussels (AR-7)

Freshwater mussels in the Hydroelectric Reach and in the Klamath River downstream from Iron Gate Dam are anticipated to experience deleterious effects during dam decommissioning due to high suspended sediment levels, bedload movement, and low dissolved oxygen concentrations.

The Updated Aquatic Resource Measure AR-7 (Appendix B: *Definite Plan – Updated AR-7, October 2018 Update*) proposes a salvage and relocation plan to be prepared prior to Lower Klamath Project dam removal. Actions would include completing a reconnaissance of existing freshwater mussels from Iron Gate Dam to Cottonwood Creek to document abundance and distribution and identifying potential translocation habitat downstream from the Trinity River confluence (RM 43.3), and between J.C. Boyle Dam (RM 229.8) and Copco No. 1 Reservoir (RM 208.3). Freshwater mussels would be salvaged and relocated prior to reservoir drawdown. It is anticipated based on existing data that up to 20,000 mussels would be translocated.

2.7.8.2 Terrestrial Resource Measures

The Proposed Project includes Terrestrial Resource Measures for northern spotted owl, bald eagle and golden eagle, special-status wildlife species, bats, special-status plants, and vegetation communities and wetlands. The measures include ensuring the presence of a biological monitor during construction-related activities (e.g., structure demolition, ground disturbance), biological awareness trainings for all construction

[17] Please note that there is no proposal submitted for an AR-5. The numbering in the EIR follows that in Appendix B: *Definite Plan – Appendix I.*

personnel, requirements to delineate the Limits of Work and prohibit construction-related traffic outside the boundaries, wildlife exclusion and entrapment, willow flycatcher habitat surveys, nesting bird surveys, and other wildlife surveys. These measures are briefly described below, and additional detail is presented in Appendix B: *Definite Plan – Appendix J*. Analysis of the KRRC proposed Terrestrial Resource Measures as part of the Proposed Project is included in Section 3.5 *Terrestrial Resources* of this EIR.

The KRRC has initiated surveys associated with most of the measures described below, including (a) gathering information on habitat and identifying access for subsequent wildlife surveys (spring and summer 2018); (b) implementing General Wildlife Surveys to document baseline information on the presence of special-status species and their habitats, which included documenting any wildlife signs such as bird nesting, dens, or burrows (May and June 2018); (c) conducting surveys for osprey, peregrine falcon, greater sandhill crane, and heron colonies (May 2018); (d) implementing ground- and aerial-based surveys to document bald and golden eagles (January, February, and June 2018); and (e) assessing structure use by bats (2017 and 2018).

The results of these surveys are anticipated to be available soon and would be incorporated into the final resources protection plans and into construction planning to avoid and minimize effects. It is anticipated that avoidance and mitigation measures to be incorporated into regulatory approvals would be developed in coordination with the USFWS, the CDFW, and the ODFW. The work plans and planned avoidance and minimization measures are summarized below and presented in Appendix B: *Definite Plan – Appendix J*.

Northern Spotted Owl Measures

The Proposed Project includes identifying suitable habitat for the northern spotted owl using a Relative Habitat Suitability model within one mile of Copco No. 1, Copco No. 2, and Iron Gate dams and facilities. If suitable habitat is identified within a noise disturbance distance (i.e., one mile to account for blasting at dams, 0.5 miles of the Limits of Work to account for other construction-related noise disturbance), protocol-level surveys would be conducted. Survey methodology and Relative Habitat Suitability model results are detailed in the Northern Spotted Owl section of Appendix B: *Definite Plan − Appendix J*. If any nest locations are documented, the Proposed Project includes seasonal restrictions (March 1–September 30) to minimize disturbance to young prior to fledgling. Limited operating periods can be waved in the event of nest failure if confirmed by a biologist. To prevent direct injury of young resulting from aircraft, no helicopter flights would occur within or at an elevation lower than 0.8 km (0.5 mi) of suitable nesting and roosting habitat during the entire breeding season unless the protocol level surveys identify no activity centers.

Bald and Golden Eagle Measures

The Proposed Project includes conducting ground and aerial-based surveys to identify the presence of bald and golden eagles within 2 miles of construction and demolition sites, and 0.5 miles from other areas within the Limits of Work including reservoir boundaries (conducted in January/early February 2018 and June 2018). The KRRC also proposes to re-survey the area in the year prior to drawdown to establish a baseline of normal behavior prior to implementing construction. Additionally, the KRRC would develop an Eagle Avoidance and Minimization Plan in coordination with the USFWS that identifies procedures and protocols for avoiding and minimizing impacts. Avoidance and minimization measures would include cutting of vegetation and grubbing outside of the sensitive eagle nesting season and incorporating a 0.5-mile restriction buffer if a nest is within 2 miles of the Limits of Work (the buffer may be reduced if a topographic feature reduces the line of site). Surveys methodology, preliminary results, and avoidance and minimization measures are described in the Bald Eagle and Golden Eagles Measures sections in Appendix B: *Definite Plan – Appendix J*.

Special-status Wildlife Measures

Special-status wildlife measures incorporate a field reconnaissance effort; general wildlife surveys; nest location surveys for species that use the same nest locations in subsequent years (e.g., osprey, peregrine falcon, sandhill crane, heron colonies); pre-construction nesting bird surveys (between February and July) within 300 feet of the Limits of Work, and construction monitoring. Special-status species, such as the tricolored blackbird and western pond turtle would be noted during these surveys. The measure includes avoidance and minimization measures, such as construction monitoring, environmental awareness training, wildlife exclusion, and identification of nesting buffers, including consideration of the species, noise effects, line of sight, and other site-specific considerations. Survey methodology and avoidance and minimization measures are described in the Special-Status Wildlife Species Measure section in Appendix B: *Definite Plan – Appendix J*.

Bats Measures

The Proposed Project includes components to avoid and minimize both short and long-term construction-related impacts and loss of habitat on roosting bats. The measures would include a site reconnaissance and daytime visual inspection of structures to identify presence of bats, hibernacula (winter roost) surveys, and spring migration surveys using visual observation (e.g., emergence surveys) and acoustic monitoring. Avoidance and minimization measures may include exclusion, seasonal restrictions on demolition, preservation of existing habitat, and creation of alternative replacement bat habitat. Survey methodology, preliminary results, and avoidance and minimization measures are described in the Bat Measure section in Appendix B: *Definite Plan – Appendix J*.

Special-status Plants Measures

As part of the Proposed Project, comprehensive floristic surveys would be conducted for special status-plants within the construction Limits of Work where ground-disturbing activities would occur. An established buffer, like a 100-meter buffer around disposal sites and a 10-meter buffer off of access and haul roads would also be required. If any special-status plants are documented, the project design would be modified if possible to avoid them. Where avoidance is not feasible, a combination of relocation, propagation, and establishment of new populations in designated conservation areas would be implemented, as determined in coordination with the resource agencies. Additionally, as part of the Proposed Project, invasive plant species would be controlled by implementing measures such as routine washing of construction vehicles and equipment. Survey methodology and minimization measures are described in Appendix B: *Definite Plan – Appendix E –Special Status Plant Species*.

Vegetation Communities and Wetland Measures

The Proposed Project identifies a number of pre-construction measures to reduce impacts on wetland and riparian habitats. First, a wetland delineation would be conducted within the Limits of Work around the dams and facilities, access and haul roads, and disposal sites in accordance with the 1987 USACE Wetland Delineation

Manual (USACE 1987) and applicable Regional Supplements (i.e., Western Mountains, Valleys, and Coast Region [USACE 2010] and Arid West [USACE 2008]) (Appendix B: *Definite Plan – Appendix J*). The results of the wetland delineation would be incorporated into the project design to avoid and minimize direct impacts on wetlands to the maximum extent feasible. Wetland areas adjacent to the construction Limits of Work would be fenced to prevent inadvertent entry during construction. Additionally, the Proposed Project would include pollution and dust control measures to reduce potential impacts to water quality in wetlands and other waters during construction.

The Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) includes details for the installation of native plants that represent the vegetation communities and wetland habitats. Aerial, barge, or hand seeding would be implemented in appropriate areas to re-vegetate all areas disturbed during construction, including reservoir areas, demolition and disposal sites, staging, access and haul roads, and turn-arounds. The goal of the management plan would be no net loss of wetland or riparian habitat acreage and functions.

Wetlands established in restored areas would be monitored for five years or until the performance criteria (as defined in Appendix B: *Definite Plan – Appendix H*) have been met. To minimize the introduction of invasive plant species into construction areas, construction vehicles and equipment would be cleaned with compressed water or air within a designated containment area to remove pathogens, invasive plant seeds, or plant parts, and disposed of in appropriate disposal facilities. The plan also would contain metrics to evaluate success of minimizing invasive exotic vegetation (Section 2.7.4).

2.7.8.3 Recreation Facilities Management

While some existing recreational facilities would remain (Table 2.7-15), the Proposed Project would remove most of the existing recreational sites at Iron Gate, Copco No. 1, and J.C. Boyle reservoirs (which primarily provide fishing, boating, and reservoir day-use access) and initiates a process to add river-based recreation sites. KRRC has developed a Draft Recreation Plan which seeks to identify recreation opportunities, in coordination with stakeholders, that would offset the removal of reservoir recreation opportunities and the reduction in whitewater boating days associated with the Proposed Project (Appendix B: *Definite Plan – Appendix Q*). New river-based opportunities may include: (a) new routes and roads for river access; (b) two small to medium river recreation facilities that would accommodate 20 campsites, day use amenities, and access to the river for fishing and boating; and (c) a new trail between J.C. Boyle Dam and the Iron Gate Fish Hatchery.

The Proposed Project includes the complete removal of eight recreation sites (Table 2.7-15), including removal of structures, concrete, and pavement, and regrading and revegetating associated parking areas and trails (Appendix B: *Definite Plan – Appendix Q*). Removal of recreation sites would occur before, during, or after dam removal and the area would be planted with a native seed mix as described in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*).

Table 2.7-15. Recreation Facilities scheduled for removal under the Proposed Project.

Site Name	Existing Facilities
Copco No. 1 Reservoir	
Mallard Cove	Day-use picnic area, restrooms, boat launch with boarding dock, and interpretive signs
Copco Cove	Picnic area, restrooms, boat launch with boarding dock, and interpretive signs
Iron Gate Reservoir	
Wanaka Springs	Day-use area, campground, restrooms, fishing dock, and interpretive signs
Camp Creek (including Dutch or Scott Creek)	Day-use area, campground, boat and fishing dock, recreational vehicle (RV) dump station, interpretative display, and restrooms
Juniper Point	Day use area, campground, fishing dock, restroom, and interpretive signs
Mirror Cove	Day use area, campground, fishing dock, boat launch, interpretive signs, and restroom
Overlook Point	Picnic area and restrooms
Long Gulch	Picnic area, boat launch, and restrooms

Facilities at Fall Creek and Jenny Creek Day-Use Areas at Iron Gate Reservoir, and the Iron Gate Fish Hatchery Day-Use Area, would remain and may be upgraded or enhanced (Table 2.7-16, Appendix B: *Definite Plan – Appendix Q* and EIR Section 3.20 *Recreation*). Future enhancements at these locations would depend on the future ownership of Parcel B lands, where these three recreational facilities are located. Pursuant to the KHSA, Parcel B lands would be transferred to the respective states (or a designated third party) for public interest purposes such as tribal mitigation, river-based recreation, wetland restoration, etc. (see also Section 2.7.11 *Land Disposition and Transfer*).

Table 2.7-16. Recreation Facilities retained with potential modification under the Proposed Project.

Site Name	Existing Facilities	Potential Modification
Iron Gate Reservoir		
Fall Creek	Day-use area, picnic area, boat launch, restroom, and hiking trail	Potential modification to support continued and improved recreational access including reconstruction of the trail.
Jenny Creek	Day-use area, campground, restrooms, and hiking trails	Potential modification to support additional campsites and improved amenities.
Iron Gate Fish Hatchery Public Use Area	Day-use area, picnic areas, picnic shelter, visitor center, interpretive kiosks, restrooms, trail to the river, fishing dock, and boat launch	Potential modification to support additional facilities and a reconstructed boat ramp.

Sources: Appendix B: *Definite Plan – Appendix Q.*

2.7.8.4 Downstream Flood Control

The Proposed Project would alter the 100-year floodplain immediately downstream of Iron Gate Dam. KRRC proposes to work with the owners of the structures located within the altered 100-year floodplain to move or elevate legally established structures, where feasible. This EIR relies on modeled preliminary 100-year floodplain inundation from Iron Gate Dam to Happy Camp under an existing and Proposed Project condition (USBR 2012b), and on KRRC's categorization of downstream structures from Iron Gate Dam to Humbug Creek (the point downstream of which any change to the floodplain is expected to be less than 0.5 feet, as per USBR [2012b]) FEMA will make the final determination of the boundary of the 100-year floodplain after dam removal, and the KRRC is coordinating with FEMA to initiate the map revision process.

This Project Component replaces Mitigation Measure H-2 from the 2012 KHSA EIS/EIR. Please see Section 3.6 *Flood Hydrology* for further discussion.

2.7.8.5 Cultural Resources

KRRC is preparing a Cultural Resources Plan (Appendix B: *Definite Plan – Appendix L*) that would identify the cultural resources studies that KRRC has completed, those that are currently ongoing, and others that KRRC anticipates completing in order to comply with regulatory requirements under Section 106 of the National Historic Preservation Act and California Assembly Bill 52. The Draft Cultural Resources Plan, submitted with the Definite Plan CITE, describes consultation completed by the date of submission by KRRC and PacifiCorp, acting as FERC's non-federal representatives, for carrying out consultation pursuant to Section 106 and the status of consultation with affected tribes and other tribal organizations. The Draft Cultural Resources Plan also provides an update as of the date of submission regarding the status of consultation under Assembly Bill 52 with California Native American tribes. The final Cultural Resources Plan would incorporate mitigation measures developed through consultation under Assembly Bill 52. Please see Section 3.12 *Historical Resources and Tribal Cultural Resources* for more information.

2.7.8.6 Traffic Management

The Proposed Project includes an initial Transportation Management Plan (TMP) to minimize construction-related traffic delays and maintain safe movement of vehicles during project implementation. The Proposed Project would result in changes in traffic conditions from delivering construction equipment, hauling deconstructed materials for near- or off-site disposal, delivery of rehabilitation materials, worker access, fish hauling (as applicable), and road, bridge, and culvert improvements would be required to support the increased traffic (see also Section 2.7.1.2 *Copco No. 1 Dam and Powerhouse – Construction Access and Road Improvements*). The major access roads for each dam site are provided in Table 2.7-17 and Figure 2.7-3. The roads in Oregon associated with J.C. Boyle Dam are included in Table 2.7-17 given the likelihood that construction crews and equipment from one of the California dam sites may be moved to/from the Oregon J.C. Boyle Dam site.

Table 2.7-17. Major Local and Regional Access Roads.

Dam Site	Interstate Access Road	Regional Access Road	Local Access Road
Copco No. 1 and Copco No. 2	I-5 (in California)	Copco Road	Ager-Beswick Road
Iron Gate	I-5 (in California)	Copco Road	Lakeview Road

The major objectives of the initial Traffic Management Plan are to maintain efficient and safe movement of vehicles through the construction zone and to provide intensive public awareness of potential impacts to traffic on project haul routes and access roads. To reduce impacts from traffic delays resulting from planned work, KRRC proposes that implementation of the final Traffic Management Plan would maintain acceptable levels of service, traffic circulation, and safety during all work activities on the state and county highway/roadway system.

The initial Traffic Management Plan outlines the structure and key requirements that would be incorporated by the construction contractor into a final Traffic Management Plan (Appendix B: *Definite Plan – Appendix O2*). The final plan would incorporate the contractor's specific means and methods for construction, which could refine the approach to access and traffic management. KRRC proposes coordinating with Oregon Department of Transportation (ODOT), California Department of Transportation, Klamath and Siskiyou Counties, Oregon State Police, and California Highway Patrol.

The initial Traffic Management Plan proposes to incorporate the management strategies below into the final Traffic Management Plan.

- Public Information – adopt methods to share information regarding any current or upcoming interruptions with the public
- Motorist Information – provide advance notice to motorists detailing traffic delays
- Incident Management – develop a procedure to implement in the event of an incident

In addition, the KRRC proposes incorporating the construction strategies listed below into the final Traffic Management Plan.

- Roadway closures – consider road users when identifying the timing and location of long-term (i.e., more than one day) road closures.
- Traffic Handling and Stage Construction – provide signage and traffic control.
- Construction Access to Work Zones – install informational signs along the road to inform motorists of the construction presence.
- Haulage – haul waste material that would not remain on site during non-peak hour times.
- Emergency Detour Plan – identify detour routes for facilities that provide essential services in times of emergencies (e.g., hospitals, fire/police stations).
- Traffic Safety Effects – adopt best management practices of signage, traffic management, and dust control to reduce traffic safety hazards from hauling, use of blind or sharp corners, slow vehicles, reduced visibility due to dust.

- Pedestrians and Bicycles – provide signage to notify both construction vehicle drivers and non-motorized users of each other's presence and if an unacceptable level of risk to non-motorized user is deemed to persist, an appropriate detour would provide continued use.

2.7.8.7 Water Quality Monitoring and Construction BMPs

To reduce potential impacts on water quality in wetlands and other surface waters during construction, the Proposed Project includes the following construction best management practices (BMPs) to be implemented within the Limits of Work:

- Clean Water Act Section 402 National Pollutant Discharge Elimination System (NPDES) permits would be obtained from Oregon and California for construction activities.
- Pollution and erosion control measures would be implemented to prevent pollution caused by construction operations and to reduce contaminated stormwater runoff.
- Oil-absorbing floating booms would be kept onsite, and the contractor would respond immediately to aquatic spills during construction.
- Vehicles and equipment would be kept in good repair, without leaks of hydraulic or lubricating fluids. If such leaks or drips do occur, they would be cleaned up immediately.
- Equipment maintenance and/or repair would be confined to one location at each project construction site. Runoff in this area would be controlled to prevent contamination of soils and water.
- Dust control measures would be implemented, including wetting disturbed soils.
- A Stormwater Pollution Prevention Plan (SWPPP) would be implemented to prevent construction materials (fuels, oils, and lubricants) from spilling or otherwise entering waterways or water bodies.

In addition, the Proposed Project includes a Water Quality Monitoring Plan, which would implement water quality monitoring for 12 months of the year from at least one year prior to dam removal until up to three years following dam removal at seven locations in the Klamath Basin. According to the Water Quality Monitoring Plan, monitoring would occur at the following seven sites along the mainstem Klamath River:

- Klamath River below Keno Dam (RM 233.4; at or near USGS gage no. 11509500);
- Klamath River below J.C. Boyle Powerplant (RM 219.7; at or near USGS gage no. 11510700);
- Klamath River above Shovel Creek (RM 206.42; upstream of Copco No. 1 Reservoir)
- Klamath River below Iron Gate (RM 189.7; at or near USGS gage no. 11516530);
- Klamath River below Seiad Valley (RM 128.5; at or near USGS gage no. 11520500);
- Klamath River at Orleans (RM 59.1; at or near USGS gage no. 11523000); and
- Klamath River near Klamath (RM 6.0; at or near USGS gage no. 11530500).

Water quality monitoring immediately downstream of Keno Dam in the Upper Klamath River would assess baseline river conditions upstream of the Proposed Project Limits of Work. The Klamath River site above Shovel Creek is located approximately three river miles downstream from the Oregon-California state line and it is considered a possible location for the state line monitoring station. The final location, specifics, and duration of operation of the state line monitoring location would be determined in consultation with the State Water Board and ODEQ.

The water quality parameters measured at each of the monitoring locations in the Water Quality Monitoring Plan is summarized in Table 2.7-18. Time-series (continuous) water quality and stream discharge data along with discrete water quality samples would be collected to assess the water quality impacts of the Proposed Project. The Water Quality Monitoring Plan also contains laboratory testing of reservoir sediment samples collected in 2017 by the USGS to develop an SSC versus turbidity relationship for the reservoir sediments, including a laboratory protocol for the SSC/turbidity relationship to identify the accuracy and reliability of the relationship along with any uncertainties and specific field verification testing necessary during dam removal.

KRRC proposes to use results of the water quality monitoring and analysis to support adaptive management decision-making during and following dam removal and regarding potential impacts to aquatic resources.

Table 2.7-18. Water Quality Monitoring Plan Parameters.

Constituent	Frequency	Type of Data
Temperature	Hourly, 12 months per year	Time-series
Dissolved Oxygen	Hourly, 12 months per year	Time-series
pH	Hourly, 12 months per year	Time-series
Conductivity	Hourly, 12 months per year	Time-series
Turbidity	Hourly, 12 months per year	Time-series
SSC	Up to 24 samples pre-drawdown; weekly during drawdown, monthly following drawdown for 36 months or until TSS equals background at Keno	Discrete (auto-sampler)
SSC	4 storm events pre-drawdown; every two weeks during and after drawdown or until TSS equals background at Keno	Depth-width integrated sample
Chemical Oxygen Demand	Monthly, daily during drawdown	Discrete
Total Nitrogen	Monthly	Discrete
Total Phosphorous	Monthly	Discrete
Microcystin [-Producing Blue-green Algae] Cell Count	Monthly	Discrete

The Water Quality Monitoring Plan also specifies that the KRRC would develop a sediment characterization plan with consistent sampling and testing protocols and procedures in consultation with California and Oregon regulatory agencies to satisfy state requirements in Section 401 Water Quality Certifications to characterize the sediment quality in reservoir and riverbed sediments upstream and downstream of the Proposed Project Lower Klamath Project reservoirs, and in the Klamath River Estuary.

The Water Quality Monitoring Plan presents the KRRC's approach to monitoring water quality parameters during dam decommissioning based on Interim Measure 15 - Water

Quality Monitoring (IM-15). The Water Quality Monitoring Plan would be revised to be consistent with the water quality monitoring requirements of the final Clean Water Act Section 401 Water Quality Certifications from California and Oregon, since the Draft Clean Water Act Section 401 Water Quality Certifications from California and Oregon were under public review when this Water Quality Monitoring Plan was developed. The information collected under this plan and the development of the SCC/turbidity relationship would assist the KRRC in making adaptive management decisions during and following dam removal, in assessing the impacts of sediment decomposition, and other biological activities, on the dissolved oxygen concentrations in the Klamath River, in determining attainment of existing health related water quality standards for microcystin producing blue-green algae cell counts, and in understanding the impacts to aquatic resources. Additional Water Quality Monitoring Plan details are presented in Appendix B: *Definite Plan – Appendix M*.

2.7.8.8 Groundwater Well Management

The Proposed Project includes a Groundwater Well Management Plan, which is intended to identify groundwater wells that may be impacted by the project and provide sufficient monitoring to understand the effects, if any, on groundwater levels and water quality. If groundwater wells are found to have been adversely impacted following dam decommissioning, the KRRC would undertake measures (e.g., well deepening) to return the production rate of any affected domestic or irrigation groundwater supply well to conditions prior to dam decommissioning. There are six steps in the KRRC's proposed Groundwater Well Management Plan:

1. Database search and agency coordination
2. Outreach to land owners and residents
3. Installation of groundwater monitoring wells
4. Groundwater monitoring
5. Post-Dam removal outreach/notification of findings
6. Proposed actions to improve production rates

If the data collected during or following dam decommissioning confirms an adverse impact (i.e., loss of supply due to lowering groundwater level or adverse effect on water quality) to any potable or irrigation well, the KRRC would act to return the water well owner's supply to pre-dam decommissioning conditions. These actions could include providing temporary water supplies until long-term measures such as motor replacement, well deepening, or full well replacement are identified and implemented. Additional details are presented in Appendix B: *Definite Plan – Appendix N.*

2.7.8.9 Fire Management

The Proposed Project includes a Fire Management Plan, which sets forth fire prevention and response methods during Proposed Project activities (Appendix B: *Definite Plan – Appendix O1*). The KRRC would designate a Safety Officer available on-call 24 hours a day and 7 days a week in the event of a fire at the Proposed Project site. This Safety Officer is responsible for immediately contacting appropriate fire dispatch units, initiating fire suppression protocols, and instructing other workers in required fire prevention, fire watch, and suppression. The prevention and response methods in the Fire Management Plan are consistent with the policies and standards in local, county, state, and federal jurisdictions. Best management practices include, but are not limited to, clearing of dried vegetation or wetting-down areas to prevent wildfires in construction and deconstruction work areas where construction activities could result in open sparks or flames; maintaining all equipment to working standards; and keeping equipment clean of flammable material. The KRRC's Fire Management Plan also requires fire suppression equipment be on-site at all times and emergency contact numbers be posted, in case of a fire.

In addition to the above measures to be implemented during Proposed Project activities, the Fire Management Plan also addresses the water supply to fight wildfires following the removal of the reservoirs. KRRC's Fire Management Plan includes the development of alternative sources of water for firefighting which include installing permanent dry hydrants from which water trucks and fire engines could draw directly from the Klamath River and larger tributaries. In addition, KRRC would develop a map for use by air-based firefighting crews identifying potential water refueling locations on the Klamath River (i.e., pool features). Additional detail is presented in Appendix B: *Definite Plan – Appendix O1*.

2.7.8.10 Hazardous Materials Management

The Proposed Project would follow the Hazardous Materials Management Plan, which includes the measures described below, that are based on data from PacifiCorp, Environmental Data Resources, Inc., and local agencies. It is possible that additional recommendations would be made following the planned Phase I-Environmental Site Assessment (ESA) visits and interviews and the following any necessary Phase II Site Investigation. The Phase I report is anticipated to be released soon.

- All structures expected to be removed would be sampled and tested for asbestos containing material, lead based paint, and polychlorinated biphenyls (PCBs). Any abated material which exceed hazardous waste criteria levels for these hazards would be handled and disposed of at approved hazardous waste facilities in accordance with applicable federal and state regulations. Remaining materials would be disposed of as non-hazardous construction debris.
- All hazardous materials removed from the sites (e.g., paints, oils, and welding gases) would be either returned to the vendor, recycled, or managed and disposed of at an approved hazardous waste facility in accordance with applicable federal and state regulations.
- Transformer oils would be tested for PCBs if no data exists.
- Any tanks which contained hazardous materials would be decontaminated prior to disposal.
- Universal hazardous waste (e.g., lighting ballasts, mercury switches, and batteries) would be handled in accordance with applicable federal and state universal waste regulations.

Additional detail is presented in Appendix B: *Definite Plan – Appendix O3*.

2.7.8.11 Emergency Response

The Proposed Project includes an Emergency Response Plan. According to the plan, the construction contractor would be required to develop written procedures to help prevent incidents, to assure preparedness in the event incidents occur, and to provide a systematic and orderly response to emergencies. This plan would be closely coordinated with the chosen contractor's Health and Safety Plan, Spill Prevention and Response Plan and Fire Management Plan. Procedures documented in the plan would apply to all personnel working on site, including reviewing of emergency response procedures with all personnel assigned to the site to the extent necessary.

The plan would address, but would not be limited to, the following:

- Medical emergency—locations of hospitals
- Fire management–procedures and contacts
- Traffic incident–protocol for notification and direction for if medical attention is required
- Hazardous material spill management–development of a Spill Prevention and Response Plan to detail procedures and documentation forms to prevent and respond to spills
- Downstream hydraulic change planning–notification to the National Weather Service River Forecast Center (federal agency that provides official public warning of floods) of any planned major hydraulic change (removal of one or more of the dams) that could potentially affect the timing and magnitude of flooding below Iron Gate
- Dam or tunnel failure–notification procedures, evacuation procedures
- Catastrophic emergency (e.g., earthquake, high wind event, etc.)–notification procedures, accountability procedures to confirm all personnel are accounted for
- Security threat–cessation of all activity, notification procedures

Additional detail is presented in Appendix B: *Definite Plan – Appendix O4.*

2.7.8.12 Noise and Vibration Control

The Proposed Project includes an initial Noise and Vibration Control Plan (NVCP). The initial NVCP identifies measures to be incorporated into the final NVCP to reduce effects from day and nighttime noise levels on sensitive receptors resulting from Proposed Project construction activities. These measures would include, but are not limited to, scheduling activities during a time that would be less impactful on residents, installing sound barriers, employing blasting techniques to minimize noise and vibration disturbance, notifying residents of activities, and promptly addressing complaints.

The final NVCP, which the chosen contractor would develop, would document noise and vibration objectives based on regulatory and industry guidelines, discuss contractor staff roles and responsibilities for noise and vibration control, define noise intensive activities and timing, clearly identify sensitive receptors, evaluate construction noise levels, and outline the monitoring program for noise and vibration. Additional detail is presented in Appendix B: *Definite Plan – Appendix O5.*

2.7.9 KHSA Interim Measures

The KHSA includes series of “interim measures” (IMs) (KHSA Appendices C, D) that have been implemented by PacifiCorp since 2010 to assess and address environmental conditions and improve fisheries prior to dam removal. The KHSA defines the interim period as the period between the date that the KHSA was originally executed (February 18, 2010) and the decommissioning of the dams, which would occur once there has been a physical disconnection of the facility from PacifiCorp’s transmission grid. (KHSA, Section 1.4.) Because the IMs were developed to offset impacts from Klamath Hydroelectric Project operations, the majority of the IMs would not continue under the Proposed Project (Table 2.7-19).

Table 2.7-19. KHSA Interim Measures Relevant to California Under Existing Conditions and the Proposed Project.

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	Proposed Project
IM1 – Interim Measures Implementation Committee (IMIC)	ICP	The IMIC is comprised of representatives from PacifiCorp, other parties to the KHSA (as amended on November 30, 2016), and representatives from the State Water Board and Regional Water Board (KHSA Appendix B, Section 3.2). The purpose of the IMIC is to coordinate with PacifiCorp on ecological and other issues related to the implementation of the Non-Interim Conservation Plan Interim Measures set forth in Appendix D of the Amended KHSA.	Ongoing	Would continue separate from the Proposed Project[2]
IM2 – California Klamath Restoration Fund/Coho Enhancement	ICP	PacifiCorp would fund actions to enhance survival and recovery of coho salmon, including habitat restoration and acquisition.	Ongoing	Would not continue
IM3 – Iron Gate Turbine Venting	ICP	PacifiCorp shall implement turbine venting on an ongoing basis beginning in 2009 to improve dissolved oxygen concentrations downstream of Iron Gate Dam.	Construction complete, implementation ongoing	Would not continue[3]
IM4 – Hatchery and Genetics Management Plan	ICP	PacifiCorp would fund the development and implementation of a Hatchery and Genetics Management Plan for the Iron Gate Hatchery.	Plan development is complete, implementation ongoing	Implementation would occur for eight years after removal of Iron Gate Dam as part of the Proposed Project, see also IM19 and IM20

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	Proposed Project
IM5 – Iron Gate Flow Variability	ICP	PacifiCorp and USBR would annually evaluate the feasibility of enhancing fall and early winter flow variability to benefit salmonids downstream from Iron Gate Dam. In the event that fall and early winter flow variability can feasibly be accomplished, PacifiCorp would develop and implement flow variability plans. This IM would not adversely affect the volume of water available for Reclamation's Klamath Project or wildlife refuges.	Ongoing	Would not continue
IM6 – Fish Disease Relationship and Control Studies	ICP	PacifiCorp has established a fund to study fish disease relationships downstream from Iron Gate Dam. PacifiCorp would consult with the Klamath River Fish Health Workgroup regarding selection, prioritization, and implementation of such studies.	Ongoing	Would not continue
IM7 – J.C. Boyle Gravel Placement and/or Habitat Enhancement (one-year)	Non-ICP	PacifiCorp would provide funding for the planning, permitting, and implementation of gravel placement or habitat enhancement projects, including related monitoring, in the Klamath River upstream of Copco No. 1 Reservoir.	Ongoing	Would not continue
IM8 – J.C. Boyle Bypass Barrier Removal	Non-ICP	PacifiCorp would remove the sidecast rock barrier approximately 3 miles upstream of the J.C. Boyle Powerhouse in the Bypass Reach. This IM would help with safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout.	Complete	Completed, part of existing conditions
IM9 – J.C. Boyle Powerhouse Gage	Non-ICP	Upon the Effective Date, PacifiCorp shall provide the U.S. Geological Survey with continued funding for the operation of the existing gage below the J.C. Boyle Powerhouse.	Ongoing	Would not continue

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	Proposed Project
IM10 – Water Quality Conference	Non-ICP	PacifiCorp shall provide one-time funding of $100,000 to convene a basin-wide technical conference on water quality within one year from the Effective Date of the KHSA.	Complete	Completed, part of existing conditions
IM11 – Interim Water Quality Improvements	Non-ICP	PacifiCorp shall spend up to $250,000 per year to be used for studies or pilot projects developed in consultation with the Implementation Committee to improve water quality in the Klamath River. Additionally, PacifiCorp shall provide funding of up to $5.4 million for a water quality improvement project after KRRC acceptance of license surrender order, with an additional amount of up to $560,000 annually for operation and maintenance.	Studies and pilot projects ongoing	Studies and pilot projects would not continue. Water Quality Improvement Project would begin[2]
IM12 – J.C. Boyle Bypass Reach and Spencer Creek Gaging	Non-ICP	PacifiCorp shall install and operate stream gages at the J.C. Boyle Bypass Reach and at Spencer Creek.	Complete	Gage operation would not continue
IM13 – Flow Releases and Ramp Rates	Non-ICP	PacifiCorp would maintain current operations including instream flow releases of 100 cfs from J.C. Boyle Dam to the J.C. Boyle Bypass Reach and a 9-inch per hour ramp rate below the J.C. Boyle Powerhouse prior to transfer of the J.C. Boyle facility.	Ongoing	Would not continue
IM14 – 3,000 cfs Power Generation	Non-ICP	Upon approval by Oregon Water Resources Department, PacifiCorp would continue maximum diversions of 3,000 cfs at J.C. Boyle Dam for power generation.	Ongoing	Would not continue

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	Proposed Project
IM15 – Water Quality Monitoring	Non-ICP	PacifiCorp shall fund long-term baseline water quality monitoring to support dam removal, nutrient removal, and permitting studies, and also will fund blue-green algae and blue-green algae toxin monitoring as necessary to protect public health. Funding of $500,000 shall be provided per year. The funding shall be made available beginning April 1, 2010 and annually on April 1.	Ongoing	Would not continue
IM16 – Water Diversions	Non-ICP	PacifiCorp shall seek to eliminate three screened diversions from Shovel (2) and Negro (1) Creeks and shall seek to modify its water rights as listed above to move the points of diversion from Shovel and Negro Creek to the mainstem Klamath River.	Not yet occurred	PacifiCorp would undertake separate from the Proposed Project – see Section 3.24 *Cumulative Effects*
IM17 – Fall Creek Flow Releases	Non-ICP	PacifiCorp would continue to provide a continuous flow release to the Fall Creek Bypass Reach targeted at 5 cfs.	Ongoing	Would continue as part of existing operations
IM18 – Hatchery Funding	Non-ICP	PacifiCorp shall fund 100 percent of Iron Gate Hatchery operations and maintenance necessary to fulfill annual mitigation objectives developed by the California Department of Fish and Wildlife in consultation with the National Marine Fisheries Service (NMFS) and consistent with existing FERC license requirements.	Ongoing	Would not continue, see IM19 and IM20

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	Proposed Project
IM19 – Hatchery Production Continuity	Non-ICP	PacifiCorp will begin a study to evaluate hatchery production options that do not rely on the current Iron Gate Hatchery water supply. Based on the study results, and within six months following the DRE's acceptance of the FERC surrender order, PacifiCorp will propose a post-Iron Gate Dam Mitigation Hatchery Plan (Plan) to provide continued hatchery production for eight years after the removal of Iron Gate Dam.	Ongoing	Would be complete
IM20 – Hatchery Funding After Removal of Iron Gate Dam	Non-ICP	After removal of Iron Gate Dam and for a period of eight years, PacifiCorp shall fund 100 percent of hatchery operations and maintenance costs necessary to fulfill annual mitigation objectives developed by CDFW in consultation with NMFS.	Not yet occurred	Would occur

[1] The Interim Conservation Plan refers to the plan developed by PacifiCorp through technical discussions with NMFS and USFWS regarding voluntary interim measures for the enhancement of coho salmon and suckers listed under the ESA, filed with FERC on November 25, 2008, or such plan as subsequently modified.

[2] Per the KHSA Appendix D, Non-Interim Conservation Plan Interim Measures, following the DRE's (Dam Removal Entity or KRRC) acceptance of the license surrender order, PacifiCorp shall provide funding of up to $5.4 million for implementation of projects approved by the Oregon Department of Environmental Quality (ODEQ) and the California State and Regional Water Quality Control Boards, and an additional amount of up to $560,000 per year to cover project operation and maintenance expenses related to those projects, these amounts subject to adjustment for inflation as set forth in Section 6.1.5 of the KHSA. PacifiCorp would provide funding for these nutrient reduction projects separate from the Proposed Project (see Section 3.25 Cumulative Effects).

[3] Turbine venting at Iron Gate would not occur under the Proposed Project as the Klamath River would be restored to natural conditions that would not require turbine venting to offset the operational impacts of the Iron Gate Dam complex.

2.7.10 Land Disposition and Transfer

The Proposed Project includes the transfer of PacifiCorp lands immediately surrounding the Lower Klamath Project ("Parcel B lands") (Figure 2.7-18) from PacifiCorp to the KRRC prior to dam removal (this transfer is the subject of a separate FERC application). The Proposed Project then provides that following dam removal, the KRRC would transfer Parcel B lands to the states, or to a designated third-party transferee. The lands would thereafter be managed for public interest purposes (e.g., tribal mitigation, river-based recreation, wetland restoration, etc.) (KHSA Section 7.6.4). Pursuant to the KHSA, decisions about the land transfer would occur following dam removal, and the outcome of who the lands will ultimately be transferred to and what they will be used for is uncertain. While this draft EIR analyzes the disposition and transfer of Parcel B lands at a general level, the specific impacts associated with the transfers and any future land uses remain uncertain.

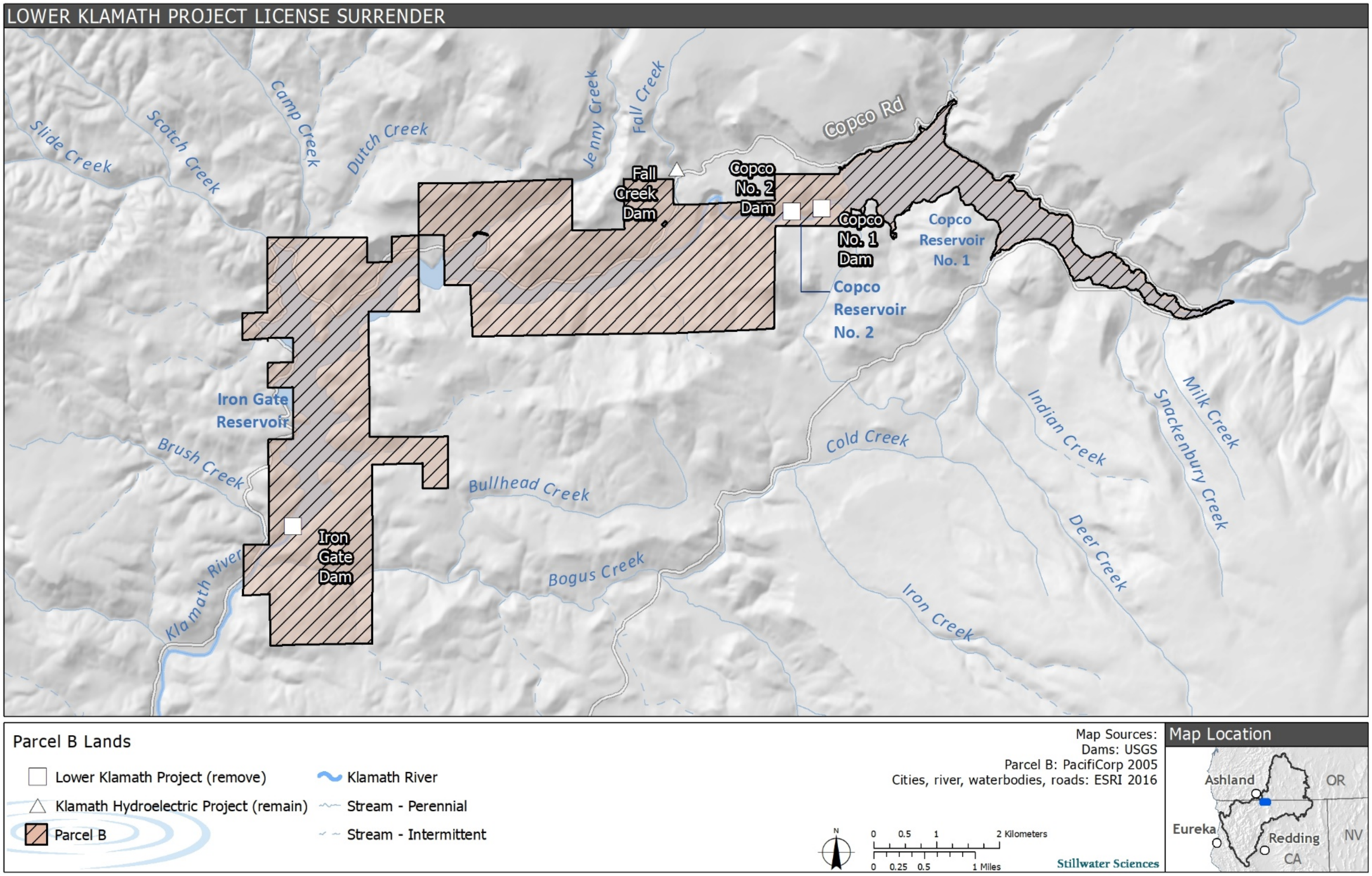

Figure 2.7-18. Parcel B Lands – California Portion.

2.8 Intended Uses of the EIR

In accordance with CEQA Guidelines section 15124, subdivision (d), this section describes the intended uses of the EIR.

The State Water Board intends to rely on this EIR for any issuance of a water quality certification for the Proposed Project under Clean Water Act section 401, including certification for a proposed decommissioning license from FERC and an anticipated application to the U.S. Army Corps of Engineers (USACE) for a discharge permit under Clean Water Act section 404. Additionally, to the extent the project requires any other water quality or water rights permits, such as any NPDES permits for hatchery operation and construction work, the State Water Board or the Regional Water Quality Control Board for the North Coast would rely on this EIR.

The Federal Power Act broadly preempts the state's authority over hydroelectric facilities. (*California v. FERC*, 495 U.S. 490 (1990); *Sayles Hydro Assocs. v. Maughan* 985 F.2d 451 (9th Cir. 1993). One of the limited exceptions to this rule is issuance of water quality certifications under Clean Water Act section 401 for FERC licensing decisions. Clean Water Act section 401 requires every applicant for a federal license or permit that could result in a discharge to the waters of a state to apply for certification from that state that their activities will be in compliance with state and federal water quality standards and other relevant requirements of state law. Conditions of a water quality certification become conditions of the federal permit or license. Thus, since there is an application before FERC to remove the Lower Klamath Project dams, the State Water Board can issue a water quality certification under certain water quality conditions or deny water quality certification based on a proposed activity's impact on the state's waters. The Federal Power Act preempts other state authority. Accordingly, the State Water Board does not anticipate that other state or local agencies would undertake permitting or other discretionary actions subject to CEQA for the proposed project. Additionally, although this draft EIR analyzes impacts of the Proposed Project to a broad range of environmental resource areas, implementation of any developed mitigation measures will depend on agreements to implement mitigation measures by the KRRC or FERC. During EIR development, this issue was discussed in multiple stakeholder forums, and this issue is discussed in greater detail throughout this draft EIR.

The California Coastal Commission has indicated that it may issue a determination of consistency with the Coastal Zone Management Act, should the KRRC prepare and submit a consistency certification and should the National Oceanic and Atmospheric Administration's (NOAA's) Office for Coastal Management grant such authority (January 31, 2017 public scoping letter, see Appendix A). The California Coastal Commission has indicated that, should it issue such a determination, the California Coastal Commission would rely on this EIR.

Multiple federal agencies would issue decisions on the Proposed Project. As previously mentioned, FERC has before it the application for decommissioning. The State Water Board anticipates that the application would also seek a "dredge and fill" permit under Clean Water Act section 404 from the USACE. The National Marine Fisheries Service and the United States Fish and Wildlife Service are the federal agencies with the authority to issue Biological Opinions on the proposed project, under the Endangered Species Act. National Marine Fisheries Service, the United States Fish and Wildlife

Service, Bureau of Land Management additionally have specific mandatory conditioning authority under sections 4(e) and 18 of Federal Power Act (16 U.S.C. § 797(e), 811). To the extent that this EIR is issued at a point in which it is useful to these federal agencies' analyses, the information contained herein may help to inform these decisions, and any environmental review under the federal National Environmental Policy Act.

Additionally, the KRRC has proposed, and FERC has approved, an Independent Board of Consultants to evaluate aspects of the KRRC's application. This EIR may provide useful information for the Board of Consultants' review.

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3 ENVIRONMENTAL SETTING, IMPACTS, AND MITIGATION MEASURES

3.1 Introduction

Section 3 of this EIR describes the environmental resources that may be affected by the Proposed Project (Sections 3.2 to 3.23), including potential cumulative effects (Section 3.24). Additionally, Section 3 provides a summary of hydrologic information (Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*) that is referenced by multiple environmental resource areas as part of the impact analyses.

Within Section 3, the environmental resource areas are organized as follows:

- 3.2 Water Quality
- 3.3 Aquatic Resources
- 3.4 Phytoplankton and Periphyton
- 3.5 Terrestrial Resources
- 3.6 Flood Hydrology
- 3.7 Groundwater
- 3.8 Water Supply/Water Rights
- 3.9 Air Quality
- 3.10 Greenhouse Gas Emissions
- 3.11 Geology, Soils, and Mineral Resources
- 3.12 Historical Resources and Tribal Cultural Resources
- 3.13 Paleontologic Resources
- 3.14 Land Use and Planning
- 3.15 Agriculture and Forestry Resources
- 3.16 Population and Housing
- 3.17 Public Services
- 3.18 Utilities and Service Systems
- 3.19 Aesthetics
- 3.20 Recreation
- 3.21 Hazards and Hazardous Materials
- 3.22 Transportation and Traffic
- 3.23 Noise
- 3.24 Cumulative Effects

Each environmental resource area section includes five parts: (1) Area of Analysis; (2) Environmental Setting; (3) Significance Criteria; (4) Impact Analysis Approach; and (5) Potential Impacts and Mitigation. A general description of each part is provided below.

3.1.1 Area of Analysis

The Area of Analysis describes the physical limits or boundaries of the Proposed Project's effects on the different environmental resource areas. Since the Proposed Project may affect each of the resources differently, the geographic scope for each resource area varies and is described in a separate Area of Analysis in each environmental resource area section.

3.1.2 Environmental Setting

The analysis of potential impacts requires a description of a project's current environmental setting as a basis for comparison against which to evaluate project impacts. Pursuant to the CEQA Guidelines Section 15125 (a), the environmental setting for comparison is conditions at the time of issuance of the Notice of Preparation. This EIR describes the relevant environmental setting characteristics of the Proposed Project for each resource area.

3.1.3 Significance Criteria

CEQA Guidelines Section 15382 defines a significant effect as a "substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project…" In setting criteria for evaluating significance, this EIR relies on scientific and factual data, analysis, consideration of relevant local, regional and state standards, and the questions presented in Appendix G of the CEQA Guidelines.

3.1.4 Impact Analysis Approach

This EIR analyzes the potential direct and reasonably foreseeable indirect effects on the environment associated with the implementation of the Proposed Project (see CEQA Guidelines Section 15358).

The impact analysis approach section describes how the analysis of potential direct and indirect effects associated with the Proposed Project was undertaken for each environmental resource area, including summaries of the data and models used in the impact analysis.

3.1.5 Potential Impacts and Mitigation

The potential impacts of the Proposed Project are evaluated by resource area. Each potential impact is introduced by a **numbered, bolded** potential impact title, followed by an analysis of how the resource area under consideration would be affected by the impact. Where appropriate, the analysis separates short-term and long-term impacts. Where the analysis indicates that the unmitigated potential impact could be significant, the EIR identifies feasible mitigation measures, if they exist. Under CEQA, mitigation can include avoiding, minimizing, rectifying, or compensating for the potential impact, or reducing or eliminating the potential impact over time (CEQA Guidelines Section 15370).

Further, CEQA Guidelines Section 15126.4 (a)(2) states that mitigation measures must be fully enforceable through permit conditions, agreements, or other legally-binding instruments. Because CEQA requires analysis of potential impacts and mitigation measures that are outside the State Water Board's regulatory purview for the Proposed Project, this EIR discusses and analyzes the effects of some mitigation measures that would not be enforceable by the State Water Board. It is the State Water Board's understanding that the KRRC may agree to implement certain mitigation measures through good neighbor agreements or other legally enforceable mechanisms (Appendix B: *Definite Plan – Section 1*). Therefore, this EIR discloses and discusses the potential effects of such mitigation, even though a legally-binding enforcement mechanism is not in place at this time.

Mitigation measures are introduced by a **numbered, bolded** mitigation measure title, followed by a description of the measure, the first time that each measure is invoked in the document. Subsequent references to a particular mitigation measure point back to the original description in this EIR.

Each resource area impact analysis concludes with a significance determination of:

- No significant impact – potential effect either would not cause any adverse alterations to existing conditions or would cause alterations but they would not result in a significant adverse effect.
- No significant impact with mitigation – significant or potentially significant adverse effect would be eliminated or reduced to an effect that is not significant with implementation of an identified mitigation measure(s).
- Significant and unavoidable – effect would be adverse and substantial, or potentially substantial, and cannot be mitigated to less than significant.
- Beneficial – effect on the resource is positive.

The cumulative effects analysis concludes with a significance determination of:

- Beneficial cumulative effects – combined effects are beneficial.
- No significant cumulative impact – combined impact of the Proposed Project and other projects would not be significant and adverse (and would also not be beneficial).
- Not cumulatively considerable – combined impact of the Proposed Project and other projects would be significant and adverse, but the incremental contribution of the Proposed Project would not be cumulatively considerable.
- Not cumulatively considerable with mitigation – combined impact of the Proposed Project and other projects would be significant and adverse, and the incremental contribution of the Proposed Project requires mitigation to reduce it to less than cumulatively considerable.
- Cumulatively considerable – combined impact of the Proposed Project and other projects would be significant and adverse, and the incremental contribution of the Proposed Project is cumulatively considerable (and there is no feasible mitigation).

3.1.6 Summary of Available Hydrology Information for the Proposed Project

The 2012 KHSA EIS/EIR evaluated the potential environmental impacts of removing J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams. As part of the analyses, Klamath River flows were modeled for periods before, during, and after dam removal in a number of technical studies referenced in the 2012 KHSA EIS/EIR[18], as well as in the environmental document itself. Flow assumptions for the model largely were based on the forecasted operations of the USBR's Klamath Irrigation Project, located in the Upper Klamath Basin. In the 2012 KHSA EIS/EIR, implementation of the Klamath Basin Restoration Agreement (KBRA) (see Section 2.6.3 *Klamath Settlement Agreements*) was considered to be a "connected action" to dam removal. Thus, the model used

[18] Key technical studies are the Klamath River total maximum daily loads (TMDL) Final Staff Report (North Coast Regional Board 2010) and the Hydrology, Hydraulics, and Sediment Transport Studies for the Secretary's Determination on Klamath River Dam Removal and Basin Restoration (USBR 2012a).

NMFS 2010 Biological Opinion (2010 BiOp) flows for analysis of the scenario where dams would remain in place, and it modified 2010 BiOp flows based on KBRA operations criteria for the Klamath Irrigation Project ("KBRA Flows") for analysis of the scenario where dams would be removed (USBR and CDFG 2012). The KBRA expired on December 31, 2015 due to a lack of Congressional authorization. Consequently, this EIR considers the potential effects of dam removal using Klamath River flows as defined by the current operational standard, the NMFS and USFWS 2013 Joint Biological Opinion for the Klamath Irrigation Project (2013 BiOp Flows) (NMFS and USFWS 2013).

The estimated Klamath River flows under the 2013 BiOp (2013 BiOp Flows) were compared to the previously modeled flows, which included KBRA operations criteria (KBRA Flows), to determine whether 2013 BiOp Flows were sufficiently similar that hydrologic model outputs developed for the 2012 KHSA EIS/EIR would still be applicable. The comparison references and builds upon an analysis conducted in the 2012 KHSA EIS/EIR Supplemental Information Report (SIR) (USBR 2016) for the same purpose. USBR (2016) concluded that the relatively small flow differences between 2013 BiOp and KBRA Flows would not substantively alter the conclusions in the 2012 KHSA EIS/EIR for those environmental resources that would be affected by flows (i.e., water quality, aquatic resources, flood risk, recreation). While the specific timing of flows changed between the 2013 BiOp and KBRA flows, the range of 2013 BiOp Flows is within the range of modeled KBRA Flows, so the previously modeled results still represent the range of conditions under 2013 BiOp Flows (USBR 2016).

Additionally, the sediment transport model developed for the 2012 KHSA EIS/EIR would produce nearly identical suspended sediment concentrations during the main drawdown period between January and May if it was run using 2013 BiOp Flows, because the 2013 BiOp and KBRA Flows are nearly identical for all water year types (generally within a few percentage points) (USBR 2016). Additional analysis presented below assesses the magnitude, timing, and distribution of flows across multiple water years to verify that the range of flows modeled under KBRA Flows are still appropriate for analyses in this EIR.

USBR's consultation with NMFS and USFWS on the 2013 BiOp Flows for the Klamath Irrigation Project is currently underway and it is expected to be completed by August of 2019. The schedule for the biological opinion has been accelerated at the direction of the President, pursuant to a Presidential Memorandum issued on October 19, 2018. At this time, estimates of flows that will be required under the future Klamath Irrigation Project biological opinion are still speculative, so they are not included in hydrologic modeling. However, the flow-related analyses in this EIR acknowledge the re-initiation of consultation on the 2013 BiOp Flows by considering the 2017 court-ordered flushing and emergency dilution flow requirements downstream of Iron Gate Dam as interim flow requirements until formal consultation is completed. The 2017 court-ordered flushing flows are not modeled as part of existing conditions hydrology for the Proposed Project, because they went into effect in February 2017 after the December 2016 Notice of Preparation was filed. These flows are discussed in several locations in this EIR, including, but not limited to, Section 3.24 *Cumulative Effects*, Section 4.2 *No Project Alternative*, and Section 4.4 *Continued Operations with Fish Passage Alternative*, where the aforementioned two alternatives assume that Iron Gate Dam would remain in place.

As appropriate, this EIR assumes that the 2013 BiOp flows in combination with the court-ordered flushing flows are the best estimate for future biological opinion flows.

3.1.6.1 Klamath River Flows under the Klamath Irrigation Project's 2013 BiOp Flows

Under the 2013 BiOp Flows, current and future (2013−2023) operations of the Klamath Irrigation Project in the Upper Klamath Basin include irrigation deliveries consistent with historic operations (subject to water availability), while maintaining Upper Klamath Lake and Klamath River hydrologic conditions that avoid jeopardizing the continued existence of listed species and adverse modification of designated critical habitat (NMFS and USFWS 2013). Operations under the 2013 BiOp Flows include two distinct, real-time water management approaches during the fall/winter (October through February) and spring/summer (March through September) periods. The fall/winter and spring/summer water management approaches prioritize different goals during the two periods, but they are designed to meet the ecological needs of the Upper Klamath Lake ESA-listed Lost River Sucker and Shortnose Sucker and ESA-listed coho salmon downstream of Iron Gate Dam, while also maintaining full irrigation deliveries in accordance with existing contracts, contingent upon available water supplies. Minimum flows downstream of Iron Gate Dam under the 2013 BiOp Flows are presented in Table 3.1-1.

Table 3.1-1. Minimum Klamath River Discharge below Iron Gate Dam under the 2013 BiOp Flows.

Month	Iron Gate Dam Average Daily Minimum Target Flows (cfs)
January	950
February	950
March	1,000
April	1,325
May	1,175
June	1,025
July	900
August	900
September	1,000
October	1,000
November	1,000
December	950

Source: NMFS and USFWS 2013

3.1.6.2 Comparison of Klamath River Flows under 2013 BiOp Flows and KBRA Operations Criteria

In the 2012 KHSA EIS/EIR, the projected Klamath River flows were modeled using the Water Resources Integrated Modeling System (WRIMS) coupled with a RiverWare-based model called the Klamath Dam Removal Model (KDRM) (USBR 2012a, 2016). The coupled model was used to analyze the Klamath River conditions using either the 2010 BiOp Flows or the KBRA Flows based on the KBRA operations criteria for the Klamath Irrigation Project. The 2010 BiOp and the KBRA Flows are generally very similar, particularly from January through May when flows are effectively the same between the two flow scenarios (USBR 2012a). The estimated Klamath River flows under the 2013 BiOp Flows were modeled using an updated and modified WRIMS model (USBR 2012b). The WRIMS model used to evaluate the 2013 BiOp Flows is also known as the Klamath Basin Planning Model (KBPM) and the modeled flow results are sometimes referred to as the "2013 BO" in USBR documents (USBR 2012b, 2016).

Modeled Klamath River flows under the 2013 BiOp and the KBRA operations criteria are nearly identical when examined on an average annual basis, with flows downstream of Iron Gate Dam averaging approximately 1,920 cfs and 1,932 cfs, respectively. The average annual 2013 BiOp and KBRA Flows downstream of Keno Dam are also nearly identical, averaging approximately 1,413 cfs and 1,434 cfs, respectively. While the modeled flows upstream and downstream of the Hydroelectric Reach are within a few percentage points on an average annual basis, some average monthly flows differ between the 2013 BiOp and KBRA flows (Tables 3.1-2 and 3.1-3). The most prominent difference is that the 2013 BiOp Flows when compared to KBRA Flows generally require higher flows in the fall months (October through December) and allow lower flows in the summer months (June through August). Downstream of Iron Gate Dam, fall 2013 BiOp Flows average approximately 200 cfs more than fall KBRA Flows; summer 2013 BiOp Flows average approximately 100 cfs less than summer KBRA Flows (Tables 3.1-2 and 3.1-3). The seasonal differences in 2013 BiOp Flows versus KBRA Flows reflect the joint goal of NMFS and USFWS to protect ESA-listed fish that rely on a shared but finite aquatic resource (most notably, the two endangered sucker species in Upper Klamath Lake and threatened coho salmon in the Klamath River below Iron Gate Dam) (NMFS and USFWS 2013).

Table 3.1-2. Average Monthly Flow at Iron Gate Dam for 2013 Joint Biological Opinion and KBRA Operations Criteria.

Month	Average monthly flow downstream of Iron Gate Dam		Differences (2013 BiOp vs. KBRA Flows)	
	KBRA Operations Criteria	2013 BiOp Operations Criteria		
	(cfs)	(cfs)	(cfs)	(percent)
Oct	1050	1263	213	20 percent
Nov	1149	1387	239	21 percent
Dec	1546	1744	197	13 percent
Jan	2061	2131	70	3 percent
Feb	2628	2545	-83	-3 percent
Mar	3390	3381	-9	0 percent
Apr	3340	3119	-222	-7 percent
May	2431	2523	92	4 percent
Jun	1910	1777	-132	-7 percent
Jul	1272	1096	-177	-14 percent
Aug	1090	1056	-34	-3 percent
Sep	1174	1167	-7	-1 percent

Source: Modified from USBR (2016).

Table 3.1-3. Average Monthly Flow at Keno Dam for 2013 Joint Biological Opinion and KBRA Operations Criteria.

Month	Average monthly flow downstream of Keno Dam		Differences (2013 BiOp vs. KBRA Flows)	
	KBRA Operations Criteria	2013 BiOp Operations Criteria		
	(cfs)	(cfs)	(cfs)	(percent)
Oct	664	885	220	33 percent
Nov	743	980	237	32 percent
Dec	1023	1245	222	22 percent
Jan	1455	1510	55	4 percent
Feb	1925	1850	-74	-4 percent
Mar	2644	2639	-6	0 percent
Apr	2661	2448	-213	-8 percent
May	1858	1960	102	5 percent
Jun	1489	1354	-135	-9 percent
Jul	929	770	-159	-17 percent
Aug	758	748	-10	-1 percent
Sep	803	822	19	2 percent

Source: Modified from USBR (2016).

Figures 3.1-1 and 3.1-2 present monthly flow exceedances for modeled 2013 BiOp and KBRA Flows downstream of Iron Gate Dam and Keno Dam, respectively. In the figure legends, modeled 2013 BiOp Flows are labeled as “2013 BO”, while modeled KBRA Flows are labeled as “KDR KBRA.” Monthly flow exceedance plots are particularly useful for comparing differences between modeled 2013 BiOp and KBRA Flows for different water year types (i.e., wet, median, and dry year types). Here, a wet year type is defined as the highest 10 percent of flows, such that wet year flows are characterized by those at the 10 percent exceedance point in Figure 3.1-1 and 3.1-2 (i.e., typical wet year flows would be exceeded 10 percent of the time). Similarly, a median year is characterized by flows at the 50 percent exceedance point, while a dry year is characterized by flows at the 90 percent exceedance point. While Table 3.1-2 and Table 3.1-3 summarize modeled *average* monthly flows under the 2013 BiOp and KBRA operations criteria, the monthly flow exceedance plots in Figure 3.1-1 and Figure 3.1-2 present the range of possible flows by month under the two operations scenarios.

The monthly flow exceedance plots generally indicate either a temporal shift in the distribution of flows expected within a given month or a shift in the water year type distribution of. In either case, the overall range of 2013 BiOp and KBRA Flows is similar between the two curves (Figures 3.1-1 and 3.1-2). A temporal shift in the distribution of flows expected within a given month is indicated by comparing modeled 2013 BiOp and KBRA Flows across different months. For example, the first panel in Figure 3.1-1 shows that flows in the Klamath River downstream of Iron Gate Dam in October under the 2013 BiOp Flows would be 150 to 400 cfs greater than under the KBRA Flows, regardless of whether it is a wet year (i.e., 10 percent exceedance), a median year (i.e., 50 percent exceedance), or a dry year (i.e., 90 percent exceedance). In October, the modeled 2013 BiOp Flows at Iron Gate Dam range from slightly greater than 1,600 cfs to approximately 1,000 cfs, which is different from the range of modeled KBRA Flows in October, but very similar to the range of modeled KBRA Flows in September. The KBRA Flow exceedance curve for the month of September ranges from slightly less than 1,600 cfs to slightly less than 1,000 cfs with a similar shape as the October 2013 BiOp Flows, such that the October 2013 BiOp Flows represent a one-month temporal shift of the September KBRA Flows. Similar shifts in the monthly distribution of flows also occur in July and August downstream of Iron Gate Dam where the range and shape of the July 2013 BiOp Flows are within approximately 100 cfs or less of the August KBRA Flows (Figure 3.1-1).

The shift in the distribution of flows by water year type is characterized by whether the flow within individual months is higher during some water year types and lower during other water year types when comparing between 2013 BiOp and KBRA Flows. Variations between the modeled 2013 BiOp and KBRA Flows during different water year types is evaluated by comparing the flows at the 10 percent exceedance for wet years, 50 percent exceedance for median years, and 90 percent exceedance for dry years. At both Iron Gate and Keno dams from July through September, the modeled 2013 BiOp Flows are less than modeled KBRA Flows during wet years (e.g., 10 percent exceedance), while the 2013 BiOp Flows are greater than KBRA Flows during dry years (e.g., 90 percent exceedance) (Figure 3.1-1 and 3.1-2). The lower left panel of Figure 3.1-1 highlights this trend during July at Iron Gate Dam where the wet year 2013 BiOp Flow is approximately 700 cfs less than the KBRA Flow, the median year 2013 BiOp Flow is approximately 100 cfs less than the KBRA Flow, and the dry year 2013 BiOp Flow is approximately 200 cfs greater than the KBRA Flow. At both Iron Gate and Keno dams, June is a unique month where there is both a monthly temporal shift in the range of flows (i.e., KBRA Flows in May bracket the range of 2013 BiOp Flows in June) and a water year type shift (i.e., 2013 BiOp Flows are greater than KBRA Flows in wet years, less in median years, and approximately the same in dry years).

Despite the aforementioned differences between the modeled 2013 BiOp and KBRA Flows, the KBRA Flows capture the range of possible 2013 BiOp Flows in the Klamath River at Iron Gate and Keno dams (Figure 3.1-3). At Iron Gate Dam, a comparison of the maximum flow exceedances under the 2013 BiOp and KBRA operations criteria in Figure 3.1-3 shows the maximum range of 2013 BiOp Flows in the Klamath River is represented by KBRA Flows, because maximum monthly KBRA Flows are greater than the maximum monthly 2013 BiOp Flows for flow exceedances of 10 percent or less (representing wet water years). Additionally, at Iron Gate Dam, the minimum monthly KBRA Flows capture the range of the minimum monthly 2013 BiOp Flows as shown by how flow exceedances of 90 percent or more (representing dry water years) for KBRA Flows are less than flow exceedances of 90 percent or more for 2013 BiOp Flows (Figure 3.1-3). Flow exceedances where the minimum 2013 BiOp Flows are less than minimum KBRA Flows (i.e., minimum flow exceedances 50 percent or less) or the maximum 2013 BiOp Flows are greater than the maximum KBRA Flows (i.e., maximum flow exceedances 40 to 15 percent) are due to shifts in the distribution of flows by water year type as previously discussed. All flow exceedances where the minimum or maximum 2013 BiOp Flows are different than the minimum or maximum KBRA Flows are still contained within the flow exceedances less than 10 percent or greater than 90 percent for KBRA Flows, so the range of 2013 BiOp Flows are still bracketed by the range of KBRA Flows.

It is reasonable to assume the outputs of hydrologic models using the KBRA Flows represent the entire range of results of hydrologic models using the 2013 BiOp Flows because the entire range of modeled 2013 BiOp Flows at Iron Gate and Keno dams is captured by modeled KBRA Flows. Farther downstream of Iron Gate Dam, Klamath River flow estimates are only affected by assumptions regarding tributary inflows (accretions) that are not affected by operations of the Klamath Irrigation Project[19]. While variations may exist in timing between 2013 BiOp and KBRA Flows, the range of model results would be similar if the 2013 BiOp Flows were used in the hydrologic model rather than the KBRA Flows, since the KBRA Flows bracket the 2013 BiOp Flows.

In summary, the hydrologic model outputs previously developed using the KBRA Flows for the 2012 KHSA EIS/EIR are sufficient to estimate conditions under 2013 BiOp Flows. As explained above, the primary differences are temporal shifts in the flow distribution within some months and changes in expected flows in different water year types. The previous KBRA Flows bracket the range of 2013 BiOp Flows, supporting the conclusion that the prior modeling using the KBRA Flows sufficiently represents the range of potential effects of Klamath River flows under the 2013 BiOp Flows.

Consequently, this EIR considers the potential effects of dam removal under the Proposed Project by applying existing hydrology information presented in the 2012 KHSA EIS/EIR, as well as in the numerous technical studies that were foundational to that effort.

[19] PacifiCorp coordinates operations with the USBR and operates the Lower Klamath Project in compliance with the 2013 BiOp for the Klamath Irrigation Project. The 2013 BiOp does not require independent releases from the Lower Klamath Project to supply the minimum flow requirements downstream of Iron Gate Dam.

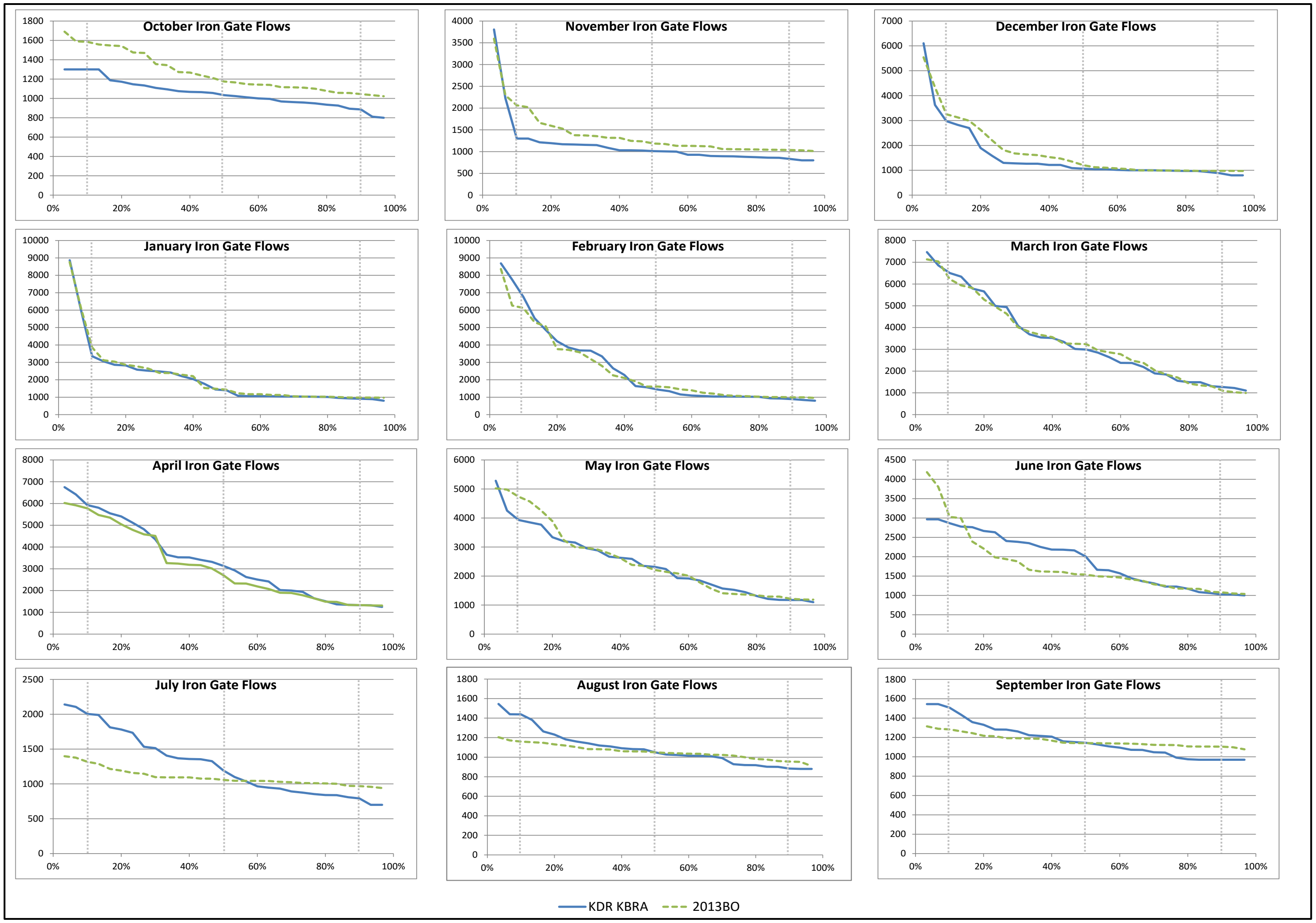

Figure 3.1-1. Monthly Flow Exceedance Curves at Iron Gate Dam for the KBRA Flows (KDR KBRA) and 2013 Joint Biological Opinion Flows (2013 BO). Source: USBR 2016. Note: The scale on the y-axis (flow in cfs) varies significantly between months. Vertical grey dotted lines indicate the 10 percent (wet year), 50 percent (median year), and 90 percent (dry year) flow exceedances.

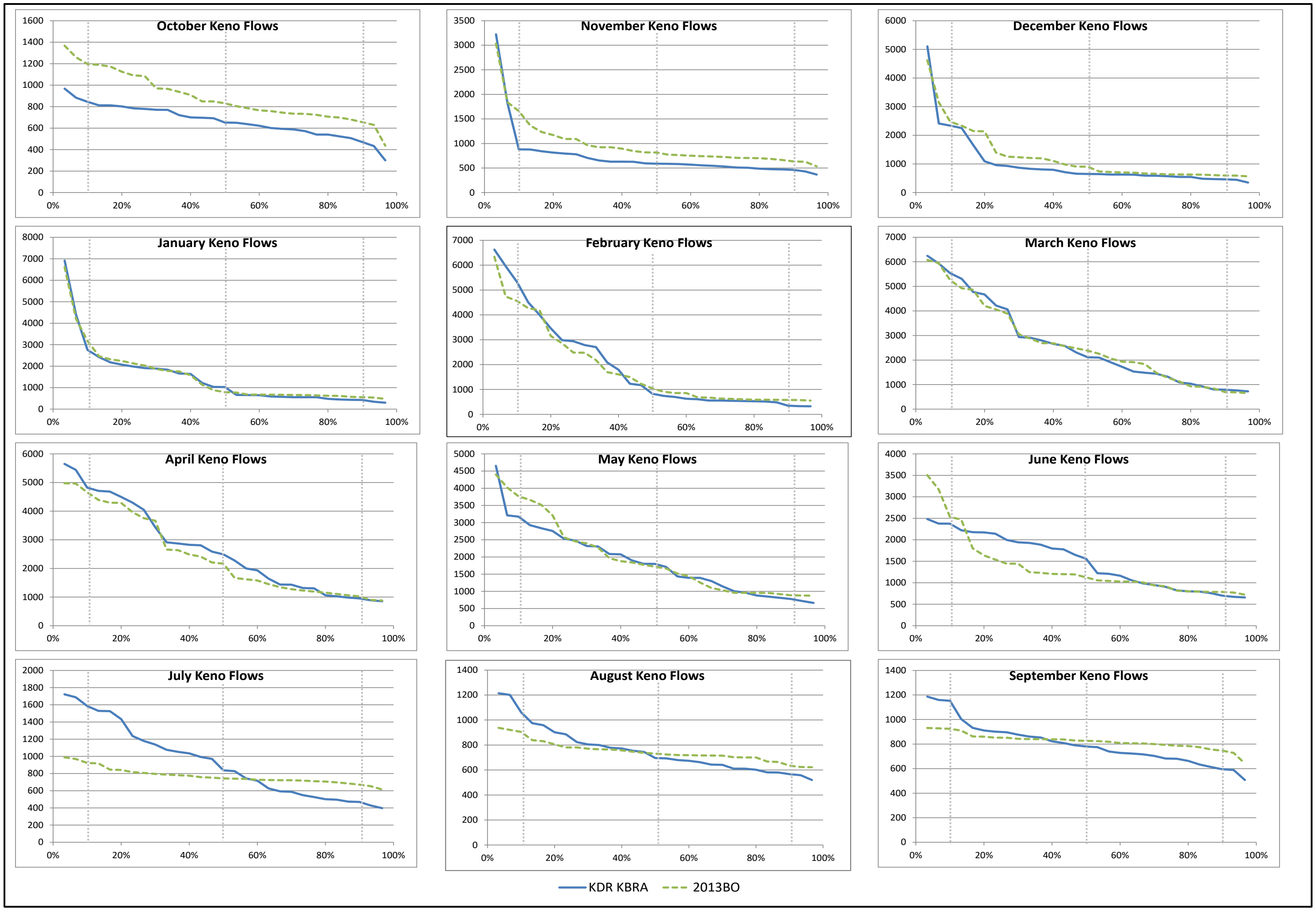

Figure 3.1-2. Monthly Flow Exceedance Curves at Keno Dam for the KBRA Flows (KDR KBRA) and 2013 Joint Biological Opinion Flows (2013 BO). Source: USBR 2016. Note: The scale on the y-axis (flow in cfs) varies significantly between months. Vertical grey dotted lines indicate the 10 percent (wet year), 50 percent (median year), and 90 percent (dry year) flow exceedances.

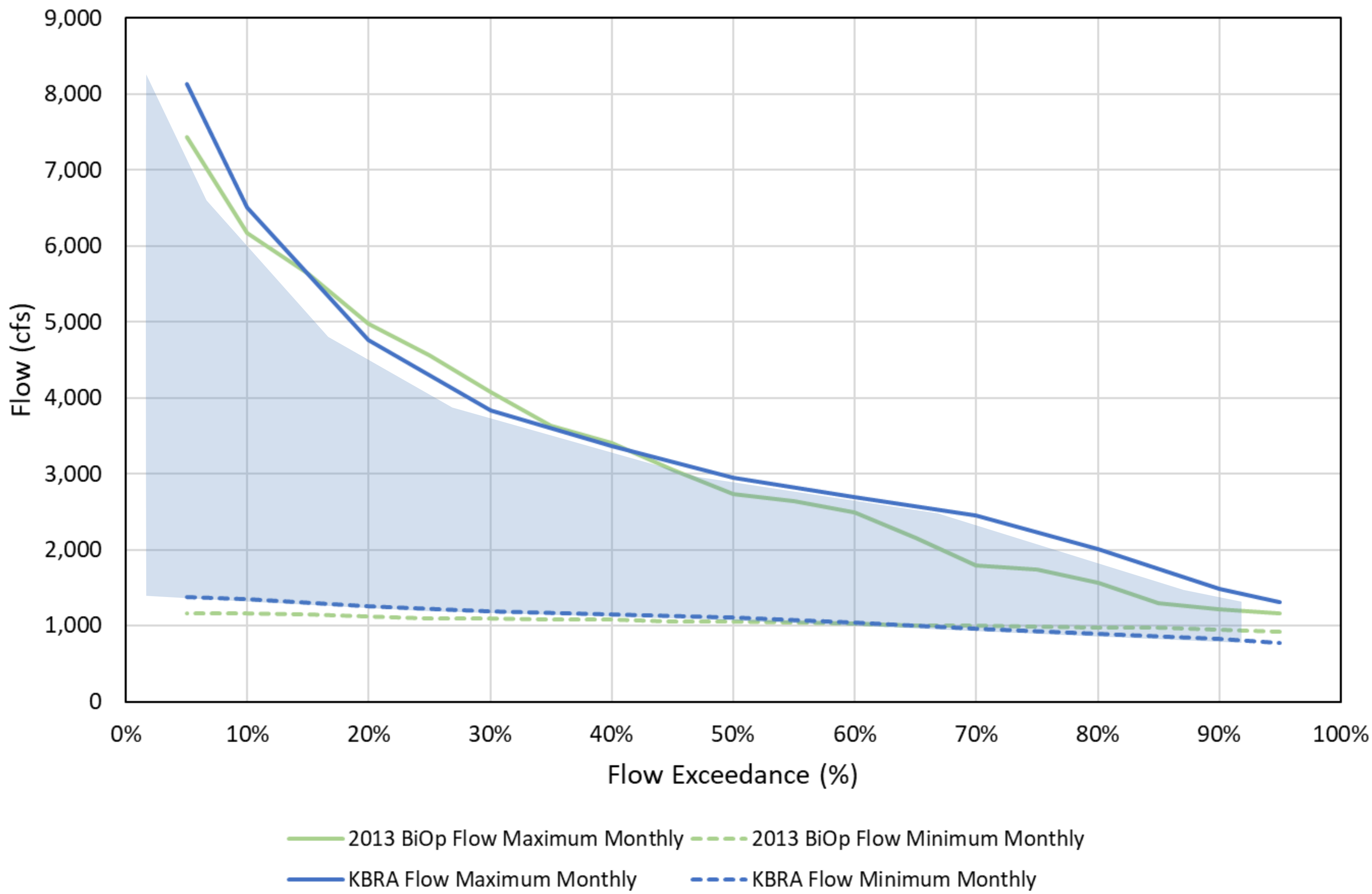

Figure 3.1-3. Comparison of the Maximum and Minimum Monthly Flow Exceedance Curves for the 2013 BiOp and KBRA Flows Between the 5 Percent and 95 Percent Exceedance Flows. Data source: USBR 2012a and USBR 2012b.

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3.2 Water Quality

This section focuses on potential water quality effects due to the Proposed Project. Other sections of this EIR discuss *Flood Hydrology (*Section 3.6*)*, *Groundwater (*Section 3.7*)*, and *Water Supply/Water Rights (*Section 3.8*)*.

Many comments were received during the NOP public scoping process relating to water quality (see Appendix A). A number of comments focused on the potential effects of dam removal on Klamath River water quality, including short-term exceedances of federal, state, and/or tribal water quality objectives and the potential for release of contaminants contained within reservoir sediments. With respect to long-term impacts on water quality, several comments noted that analyses in the EIR need to consider dam removal, as well as alternatives where dams remain in place, within the context of the existing Klamath River total maximum daily loads (TMDLs). There were numerous comments regarding the potential for dam removal to alleviate existing impaired conditions for water temperature, dissolved oxygen, and blue-green algae[20] and associated algal toxins. Conversely, some commenters indicated their belief that the Lower Klamath Project reservoirs improve water quality by serving as a sink for phosphorus and reducing downstream summer time water temperatures, or otherwise improving water quality in an unspecified manner. Additional summary of the water quality comments received during the NOP public scoping process, as well as the individual comments, are presented in Appendix A.

3.2.1 Area of Analysis

The Area of Analysis for water quality includes multiple reaches of the Klamath River, as listed below and shown in Figure 3.2-1.

Upper Klamath Basin

- Hydroelectric Reach[21] (upstream end of J.C. Boyle Reservoir to Iron Gate Dam)

Mid-Klamath Basin

- Klamath River from Iron Gate Dam downstream to the confluence with the Salmon River
- Klamath River from the confluence with the Salmon River to the confluence with the Trinity River

Lower Klamath Basin

- Lower Klamath River from the confluence with the Trinity River to the estuary
- Klamath River Estuary

[20] Blue-green algae are a type of phytoplankton that are naturally found in lakes, streams, ponds, and other surface waters which can produce toxic compounds (e.g., microcystin) that have harmful effects on fish, shellfish, mammals, bird, and people (USEPA 2014). Though blue-green algae is technically a cyanobacteria, it is commonly referred to as an algae. For readability, and to reduce confusion, this EIR refers to cyanobacteria as blue-green algae except when a cited reference specifically uses the term cyanobacteria.
[21] Note that the portion of the Hydroelectric Reach that extends into Oregon (i.e., from the Oregon-California state line [RM 214.1] to the upstream end of J.C. Boyle Reservoir) is only being considered to the extent that conditions in this reach influence water quality downstream in California.

- Pacific Ocean nearshore environment

Table 3.2-1 lists the river mile locations of the above reaches and of features relevant to the water quality Area of Analysis.

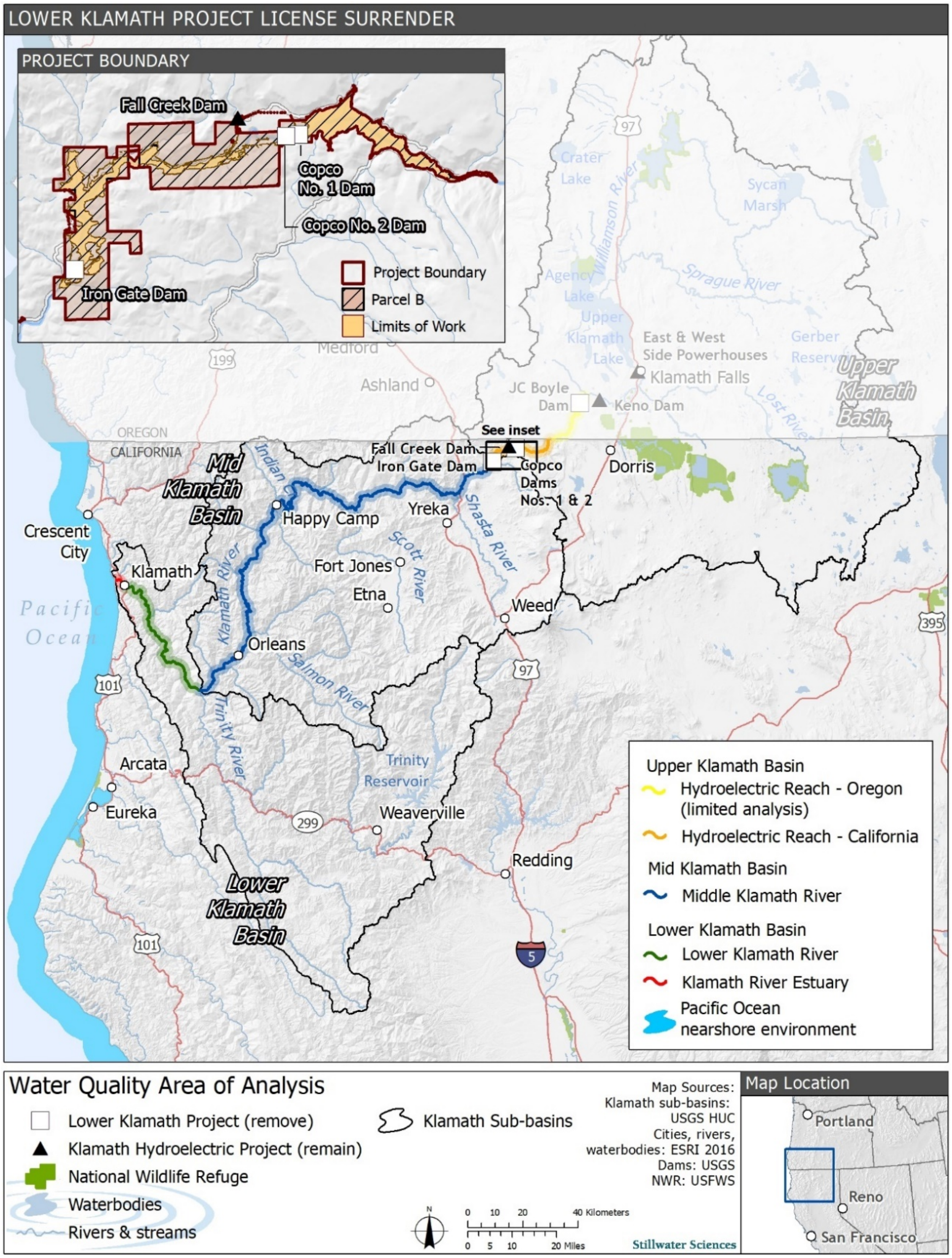

Figure 3.2-1. Klamath River Reaches Included in the Area of Analysis for Water Quality.

Table 3.2-1. River Mile Locations of Klamath River Features Relevant to the Water Quality Analysis.

Feature	River Mile[1]
Upper Klamath Basin	
J.C. Boyle Reservoir	229.8 to 233.3
Oregon-California state line	214.1
Copco No. 1 Reservoir	201.8 to 208.3
Copco No. 2 Reservoir	201.5 to 201.8
Iron Gate Reservoir	193.1 to 200.0
Mid-Klamath Basin	
Klamath River confluence with Shasta River	179.5
Klamath River confluence with Scott River	145.1
Seiad Valley	132.7
Klamath River confluence with Salmon River	66.3
Orleans	58.9
Hoopa Valley Tribe Reservation lands	44.8 to 45.8
Weitchpec	43.6
Lower Klamath Basin	
Yurok Reservation Lands	0 to 45
Klamath River confluence with Trinity River	43.3
Klamath River confluence with Turwar Creek	5.6
Klamath River Estuary	0 to 3.9

Notes:
[1] River Mile (RM) refers to distance upstream of the mouth of the Klamath River. RM's have been updated from the Detailed Plan (see Appendix B: *Detailed Plan*) to those of the Definite Plan (see Appendix B: *Definite Plan – Section 1.4*).

3.2.2 Environmental Setting

This section provides a description of the environmental setting for water quality resources in the Area of Analysis, including a brief overview of water quality processes in the Klamath Basin to inform subsequent impact analyses.

3.2.2.1 Overview of Water Quality Processes in the Klamath Basin

Water quality in the Klamath River is affected by the geology and meteorology of the Klamath Basin, as well as current and historical land- and water-use practices. Cold air temperatures and precipitation generally occur from November to March, corresponding to periods of higher flows and colder water temperatures. Warmer air temperatures and drier conditions occur from April to October, corresponding to periods of lower flows and warmer water temperatures. The Upper Klamath Basin has naturally elevated levels of phosphorus that combine with human activities (e.g., wetland draining, agriculture, ranching, logging, water diversions), to increase concentrations of nutrients (nitrogen and phosphorus) and suspended sediment, to degrade water quality parameters (e.g., water temperature, pH, dissolved oxygen). This, in turn, affects the water quality entering California. Within California, the Middle and Lower Klamath River is composed of generally steep, mountainous terrain (see Section 3.11 *Geology, Soils, and Mineral Resources*). Historically, hillslope and in-channel gold mining and extensive logging have occurred, along with agricultural and ranching activities that divert water in many of the lower tributary basins. These activities have altered stream flows, increased concentrations of suspended sediment and nutrients in watercourses, and increased summer water temperatures.

The presence and operations of the Lower Klamath Project facilities in the Klamath Hydroelectric Reach affect many aspects of water quality in the Klamath River. In general, the most common effects of hydroelectric project operations on water quality result from changes in the physical structure of the aquatic ecosystem. The dams alter the flow patterns in a river by slowing the transport of water downstream and modifying the timing and magnitude of flows on a short-term basis. Dams intercept and retain sediment, organic matter, nutrients, and other constituents that would otherwise be transported downstream. Dams additionally alter seasonal water temperatures when compared to free-flowing stream reaches.

In general, effects on water quality from hydroelectric project operations include:

- **River and reservoir water temperatures.** The primary effects of hydroelectric project operations on the natural temperature regime of streams and rivers are related to alterations in water surface area, depth, and velocity due to water diversions into or out of the stream corridor, including reservoir impoundments and conveyance through canals, pipelines, or penstocks. These changes influence the amount of heat entering and leaving waterbodies (such as from solar radiation and nighttime cooling), which influences the water temperature. As large reservoirs are often deep, they can retain their water temperature for weeks or months, thereby shifting the natural water temperature patterns in river reaches downstream of the reservoirs. For example, water released from reservoirs in the late spring is typically cooler than would naturally occur because the reservoir retains some of the cold water it received in the winter. Similarly, water released from reservoirs in the early fall is typically warmer than would naturally occur because the reservoir still contains water that was heated during the summer months. Additionally, due to surface heating of the reservoir in the late spring and summer, a warmer, less dense layer of water forms on the reservoir surface (the epilimnion), which overlies colder, denser water (the hypolimnion) (Figure 3.2-2). This process, called thermal stratification, often persists for months.

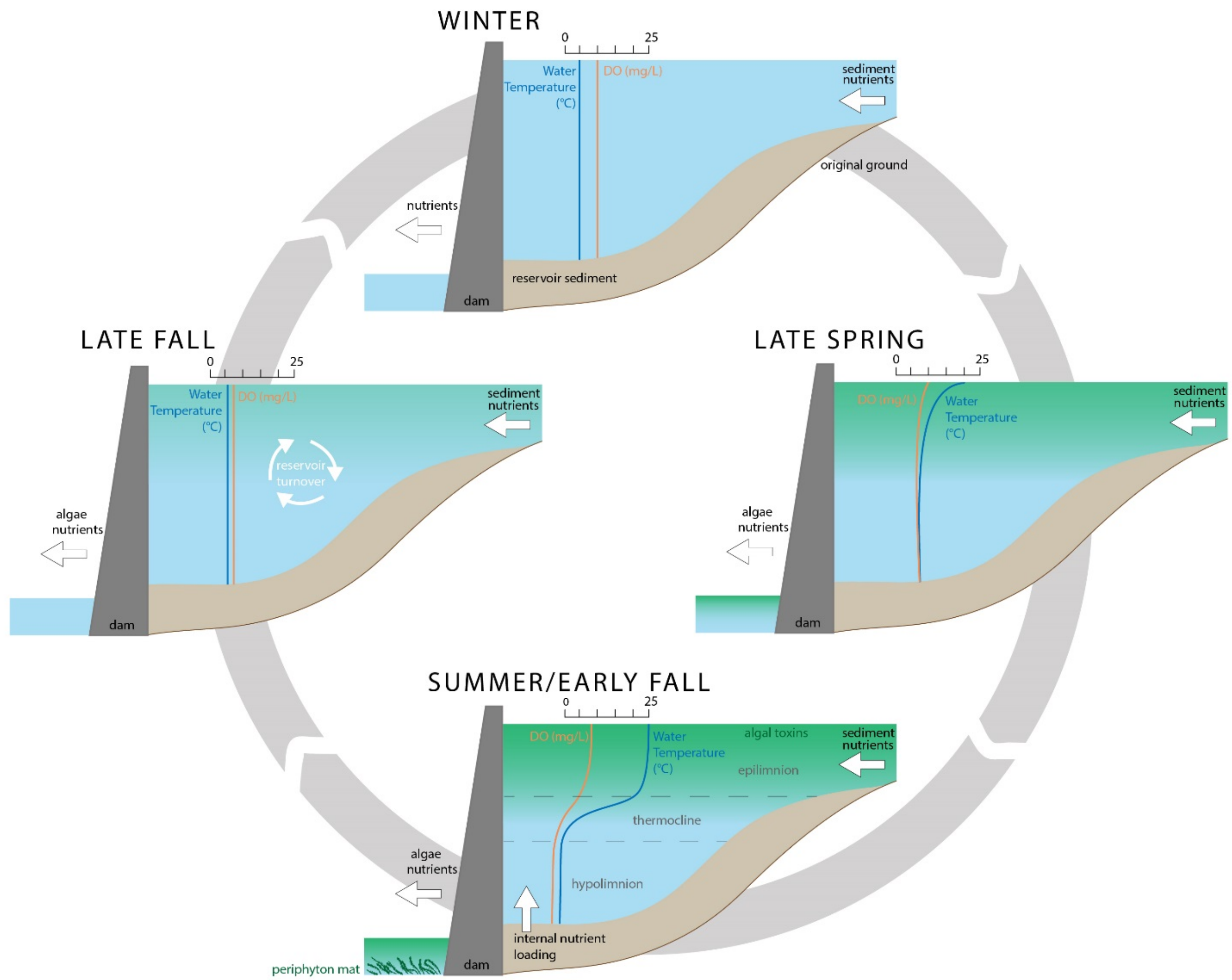

Figure 3.2-2. General Seasonal Pattern of Thermal Stratification, Dissolved Oxygen Concentrations, and Algae Blooms in Relatively Deep, Productive Reservoirs in Temperate Climates, With Darker Green Shading In Surface Waters Representing a Higher Intensity of Algae Growth.

- **<u>Reservoir mixing and dissolved oxygen.</u>** The water column in the deepest portions of most large reservoirs has a characteristic thermal and chemical structure. With thermal stratification (in summer and early fall), the isolated deeper water is not exposed to the atmosphere and often completely loses its supply of dissolved oxygen over a period of weeks or months as organic matter in bottom sediments decays (anoxic) (Figure 3.2-2). Releases of this deeper, oxygen-depleted water from the bottom of the reservoir can cause serious problems for downstream fish and other aquatic biota. In late fall, thermal stratification typically breaks down as the surface water layer cools and wind mixing of the water column occurs. This process is called reservoir turnover (Figure 3.2-2).
- **<u>Phytoplankton in reservoirs.</u>** As large reservoirs have long retention times for water and thermally stratify in the summer months, they often provide ideal conditions for the growth of phytoplankton in the epilimnion. Phytoplankton are microscopic organisms, including algae, bacteria, protists, and other single-celled plants, that float in the water column of fresh and salt waters and obtain energy via photosynthesis. Depending upon available nutrients, extensive seasonal phytoplankton blooms can develop in these reservoirs (Figure 3.2-2). Phytoplankton photosynthesis during the day releases dissolved oxygen and consumes carbon dioxide. At night, phytoplankton respiration consumes dissolved oxygen and releases carbon dioxide. This can result in wide daily swings in dissolved oxygen and pH, which is stressful to aquatic biota. Under nutrient-rich conditions, harmful blooms of phytoplankton composed of blue-green algae (also referred as cyanobacteria) can occur. Blue-green algae can produce algal toxins, which are also referred to as cyanotoxins (e.g., cyclic peptide toxins such as microcystin that adversely affects liver function and alkaloid toxins such as anatoxin-a and saxitoxin that adversely affect the nervous system). Algal toxins can be harmful to a wide range of organisms including exposed fish, shellfish, livestock, and humans. Releases of reservoir impounded waters can transport phytoplankton and/or toxins to downstream waters (Figure 3.2-2) and phytoplankton blooms can die abruptly ("crash"), releasing algal toxins into the water column. The subsequent decomposition of organic matter associated with dead phytoplankton can create periods of low dissolved oxygen in reservoir bottom waters, along with peaks of algal toxins, which adversely impact environmental and human health conditions (Figure 3.2-2). Additional information on phytoplankton and its impacts on water quality (including nitrogen fixation) can be found in *Section 3.4 Phytoplankton and Periphyton*.
- **<u>Nutrient cycling in reservoirs and internal loading.</u>** Nutrients entering reservoirs can undergo many changes and be involved in many biochemical processes. On an annual basis, the majority of nutrients entering a reservoir from a watershed are eventually discharged downstream, with only a small fraction being retained in the reservoir sediments. Dissolved nutrients (e.g., ortho-phosphorus, nitrate, and ammonium) entering a reservoir can be used directly by phytoplankton (which includes blue-green algae) when growing conditions are conducive. When phytoplankton die, they settle to the bottom of reservoirs and contribute nutrients and organic matter to the sediments. Under low dissolved oxygen conditions, nutrients contained within bottom sediments can be released back into the water column, creating a source of nutrients internal to the reservoir itself, in addition to the nutrients entering the reservoir from upstream sources. This is particularly important for phosphorus and results in highly enriched reservoir bottom waters during periods of stratification. During reservoir turnover

when the stratification breaks down, these nutrient rich waters are mixed throughout the reservoir water column and the nutrients can be released downstream, resulting in a secondary (fall) phytoplankton bloom (which includes blue-green algae) (Figure 3.2-2).

- **Sediment deposition in reservoirs**. The characteristically slow-moving waters within large reservoirs result in the deposition of sediments that enter the reservoir from the surrounding watershed (Figure 3.2-2). While large reservoirs interrupt the natural transport of both coarse sediments (e.g., sand, gravel, cobble, boulders) and fine sediments (e.g., clay, silt), contaminants found in the bottom sediments of reservoirs are typically transported from the watershed with fine sediments, which include both inorganic material and organic particulate matter. Trace metals are mostly attached to inorganic material (e.g., clays and silts). Organic contaminants, such as pesticides and dioxin, are adsorbed to (i.e., attached to the surface of) organic particulate matter, such as dead vegetation and phytoplankton.
- **Periphyton growth downstream of reservoirs.** Slow transport of water downstream and modified timing and magnitude of river flows can affect the growth of periphyton downstream of hydroelectric dams. Periphyton are aquatic freshwater organisms, including algae and bacteria that live attached to underwater surfaces such as rocks on a riverbed. Periphyton are important base components of the food web in riverine systems. Periphyton can influence riverine water quality by affecting nutrient cycling and diel (i.e., 24-hour cycle) fluctuations in dissolved oxygen and pH. Natural scouring of periphyton populations can be diminished downstream of large dams due to altered flows and interception of coarse sediment movement by the dam, leading to seasonal occurrence of large periphyton mats that can cause water quality problems and provide abundant habitat for fish parasites (see also Section 3.3.4.5 *Fish Disease and Parasites* and Section 3.4.2.2 *Periphyton*).

The following sections summarize general existing water quality conditions in the water quality Area of Analysis. Existing conditions are generally defined as physical, chemical, and biological characteristics of water in the Area of Analysis at the time of the NOP (2016). Water quality parameters analyzed in this EIR are represented by data collected within the past 10 to 17 years (2000–2017). Additional detail, including data from multiple agency and tribal monitoring programs throughout the Klamath Basin, is presented in Appendix C.

3.2.2.2 Water Temperature

Water temperatures in the Klamath Basin vary seasonally and by location. The North Coast Regional Water Quality Control Board (North Coast Regional Board) has determined that existing receiving water temperatures in the Klamath River are already too warm to support several designated beneficial uses, including cold freshwater habitat (COLD), rare, threatened, or endangered species (RARE), and migration of aquatic organisms (MIGR) annually during late summer/early fall (North Coast Regional Board 2010). All reaches of the Klamath River from the Oregon-California state line to the mouth of the Klamath River are listed as impaired for elevated water temperature on the Clean Water Act (CWA) Section 303(d) list. As a result, the North Coast Regional Board has developed TMDLs for water temperature in the Klamath River. A quantitative Klamath River TMDL model was created to determine what natural water temperature conditions would be in the Klamath River, and then the model was used to determine how flow modifications, water withdrawals, and other human activities alter water temperatures, forming the basis of the TMDLs (see Appendix D). The Klamath River TMDL allocates specific water temperature loads for Copco No. 1 and Iron Gate reservoirs, as discussed below. Properly functioning thermal refugia[22] are necessary to meet the Basin Plan water temperature objectives, as these areas of colder water in the mainstem Klamath River moderate naturally high summer water temperature conditions by providing places where fish can escape warmer temperatures. These thermal refugia support beneficial uses such as migration of salmonids (North Coast Regional Board 2011).

In the Hydroelectric Reach, water temperatures are influenced by the presence of the Lower Klamath Project facilities. The relatively shallow depth and short hydraulic residence times do not support thermal stratification in J.C. Boyle Reservoir (FERC 2007; Raymond 2008a, 2009a, 2010a) and thus this reservoir does not directly alter summertime water temperatures in further downstream reaches (NRC 2004). However, current power-peaking operations at the J.C. Boyle Powerhouse affect water temperatures in the river immediately downstream from the dam. While natural diel (24-hour) water temperature variations occur in the river, daily peaking operations at J.C. Boyle Powerhouse (river mile [RM] 225.2) result in an increase in the daily water temperature range in the Bypass Reach because warmer reservoir discharges are diverted around this reach (see also Section 2.3.1 *J.C. Boyle Dam Development*) and cold groundwater springs enter the river and dominate remaining flows (PacifiCorp 2006a; Kirk et al. 2010). Water temperatures in the Bypass Reach can decrease by 9 to 27°F when bypass operations are underway due to the influence of the springs (Kirk et al. 2010). In the Peaking Reach, which is downstream of the Bypass Reach, the flow diverted around the Bypass Reach rejoins the Klamath River (see Figure 2.3-1). At the upstream end of the Peaking Reach, the natural, cold groundwater input into the Bypass Reach, combined with fluctuations in river flow due to hydroelectric power operations in the Peaking Reach also produces an observed increase in daily water temperature range above the natural diel water temperature fluctuations (Kirk et al. 2010).

Further downstream in the Peaking Reach, near the confluence of the Klamath River and Shovel Creek (Figure 2.2-3), there are natural hot springs that contribute flows to the mainstem river. The natural hot springs were not found to result in consistent substantial warming of the Klamath River based on two sets of measurements made in November and December 2017 (KRRC 2018). Water temperature data collected upstream and downstream of the confluence of the Klamath River and Shovel Creek showed a 1.4˚F increase in the downstream direction during the November 2017 measurement, but a 0.2˚F decrease during the December 2017 measurement (KRRC 2018).

Iron Gate and Copco No. 1 reservoirs are the two deepest reservoirs in the Hydroelectric Reach. These reservoirs thermally stratify each year beginning in April/May and the warmer surface and cooler bottom waters do not mix again until October/November (FERC 2007; Raymond 2008a, 2009a, 2010a; Asarian and Kann 2011). The large

[22] Thermal refugia are typically identified as areas of cool water created by inflowing tributaries, springs, seeps, upwelling hyporheic flow, and/or groundwater in an otherwise warm stream channel offering refuge habitat to cold-water fish and other cold water aquatic species (North Coast Regional Board 2011). Cold water fish utilize thermal refugia for cold water habitat when ambient river temperatures exceed their preferred temperature range.

thermal mass of the stored water in the reservoirs delays the natural warming and cooling of riverine water temperatures on a seasonal basis such that spring water temperatures in the Hydroelectric Reach are generally cooler than would be expected under natural conditions, and summer and fall water temperatures are generally warmer (Figure 3.2-3; North Coast Regional Board 2010, Asarian and Kann 2013). In the Hydroelectric Reach, maximum temperatures, generally occur in late July and regularly exceed the range of chronic effects temperature thresholds (approximately 55–68°F) for full salmonid support in California (North Coast Regional Board 2010).

The Klamath River TMDL specifies the allowable increase in daily average (and daily maximum) water temperatures is 0.9ºF (0.5ºC) for Copco No. 1 and Copco No. 2 reservoir tailraces and 0.18ºF (0.1ºC) for the Iron Gate Reservoir tailrace to alleviate the late summer/fall warming caused by Lower Klamath Project reservoirs downstream of Iron Gate Dam under existing conditions. On average the Lower Klamath Project reservoirs increase late summer/fall water temperatures below Iron Gate Dam by approximately 4ºF to 18ºF (approximately 2ºC to 10ºC). Additionally, the Klamath River TMDL specifies a portion of Copco No. 1 and Iron Gate reservoirs must provide suitable water temperature and dissolved oxygen conditions for cold water fish during the critical summer period—thus maintaining a “compliance lens” within the reservoir that can support cold water fish. In 2015, PacifiCorp installed a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11. One of the purposes of the curtain is to isolate warmer, less dense near-surface waters while withdrawing cooler, denser, and deeper waters from the reservoir for release to the Klamath River downstream (PacifiCorp 2018). The other purpose is to isolate surface waters that have high concentrations of blue-green algae (cyanobacteria) such that extensive summer and fall blooms are not readily released downstream to the Middle and Lower Klamath River (see further discussion in Potential Impact 4.2.2-4). Results from the intake barrier/thermal curtain indicate that modest 1–2°C (1.8–3.6°F) water temperature improvement is possible (PacifiCorp 2017), although data do not indicate that this measure could achieve compliance with the Thermal Plan or to meet the Klamath River TMDLs temperature requirement in the Middle Klamath River (North Coast Regional Board (2010).

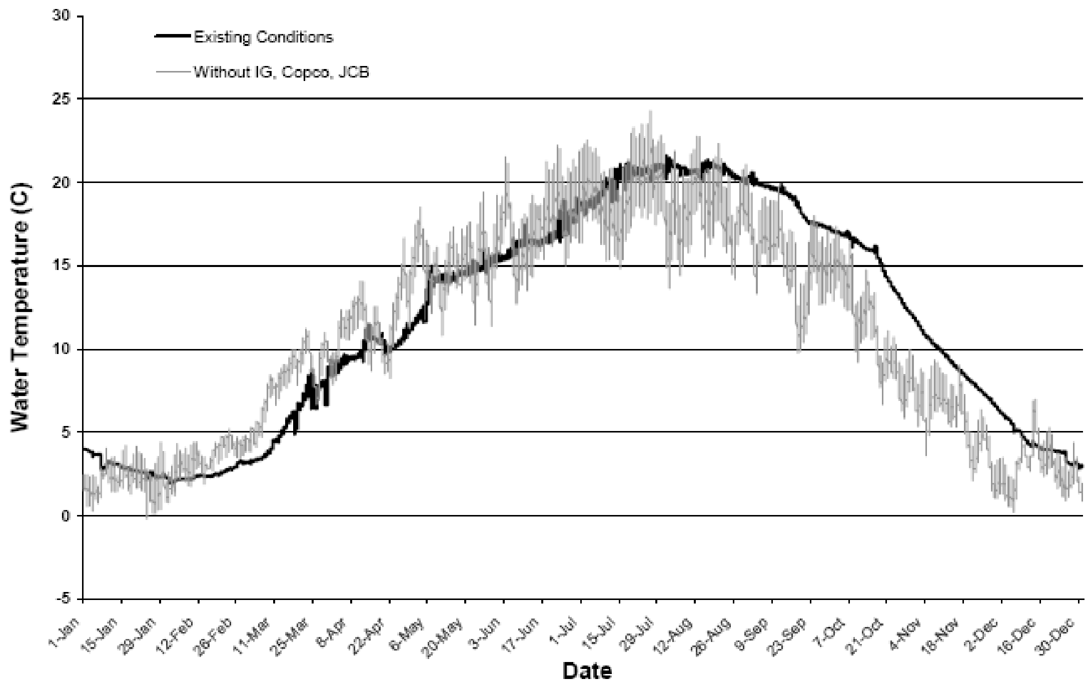

Figure 3.2-3. Simulated Hourly Water Temperature Downstream from Iron Gate Dam Based on Year 2004 for Existing Conditions Compared to Hypothetical Conditions without J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams. Source: PacifiCorp 2005.

The seasonal water temperature pattern of the Hydroelectric Reach is similar in the Klamath River immediately downstream from Iron Gate Dam, where water released from Iron Gate Dam is 1.8–4.5°F cooler in the spring and approximately 4–18°F warmer in the summer and fall as compared to modeled conditions without the Lower Klamath Project dams (PacifiCorp 2004a; Dunsmoor and Huntington 2006; North Coast Regional Board 2010). In addition to this "thermal lag", immediately downstream from Iron Gate Dam water temperatures tend to exhibit relatively low variability due to the influence of the reservoir's water releases (Karuk Tribe of California 2009, 2010a, 2010b, 2011, 2012, 2013; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Asarian and Kann 2013). Water temperature data collected since 2009 as part of KHSA Interim Measure 15 (see also Table 2.7-12) indicate that water temperature trends under the 2013 BiOp flows are consistent with those under the pre-2013 BiOp flows. For example, Asarian and Kann (2013) found that mean and maximum water temperature between 2001 and 2011 peaked each year between July and August with a maximum temperature of approximately 75°F. Although the 2013 BiOp increased minimum flows during July compared to pre-2013 BiOp flows, water temperature downstream of Iron Gate Dam peaked in July during 2013 to 2015 under 2013 BiOp flows, with a maximum temperature of approximately 75°F in mid/late July in all three years (Watercourse Engineering, Inc. 2014, 2015, 2016).

Farther downstream, the presence of the Lower Klamath Project exerts less influence on water temperatures, and the Klamath River is more influenced by solar energy, the natural heating and cooling regime of ambient air temperatures, and tributary inputs of surface water. Meteorological influences on water temperature result in increasing temperature with distance downstream from Iron Gate Dam in the summer and fall months (Basdekas and Deas 2007; Asarian and Kann 2013). For example, daily average temperatures between June and September are approximately 1.8–7.2°F higher near Seiad Valley (RM 132.7) than those just downstream from Iron Gate Dam (Karuk Tribe of California 2009, 2010a, 2010b, 2011, 2012, 2013) (see Appendix C for more detail). At the Salmon River confluence with the Klamath River (RM 66.3), the effects of the Lower Klamath Project on water temperature are significantly diminished. Downstream from the Salmon River, the influence of the Lower Klamath Project dams on water temperature in the Klamath River is not discernable from the modeled data (PacifiCorp 2005; Dunsmoor and Huntington 2006; North Coast Regional Board 2010; Perry et al. 2011; Risley et al. 2012).

Downstream from the Salmon River (RM 66), summer water temperatures begin to decrease slightly with distance as coastal weather influences (i.e., fog and lower air temperatures) decrease longitudinal warming (Scheiff and Zedonis 2011) and cool water tributary inputs increase the overall flow volume in the Klamath River (Asarian and Kann 2013). In general, however, water temperatures in this reach still regularly exceed salmonid thermal preferences (less than 68ºF) during summer months. Asarian and Kann (2013) reported that the average daily maximum water temperature[23] between 2001 and 2011 was 73.4ºF or higher between July through August from the Salmon River (RM 66) to Turwar Creek (RM 5.6). Daily maximum summer water temperatures have been measured at values greater than 78.8°F just upstream of the confluence with the Trinity River (Weitchpec [RM 43.6]), decreasing to 76.1°F near Turwar Creek (RM 5.6) (YTEP 2005, Sinnott 2010a). Maximum temperatures in the Klamath River downstream from Iron Gate Dam to the Klamath River Estuary regularly exceed the range of chronic (sublethal) effects temperature thresholds[24] (55.4–68°F) for full salmonid support in California (North Coast Regional Board 2010; Sinnott 2010a, 2011a, 2012a; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Hanington 2013; Hanington and Ellien 2013) (see Appendix C for more detail).

Water temperatures in the Klamath River Estuary are linked to temperatures and flows entering the estuary, salinity of the estuary and resulting density stratification, and the timing and duration of sand berm formation across the estuary mouth. When the estuary mouth is open, denser salt water from the ocean sinks below the lighter fresh river water, resulting in a salt wedge that moves up and down the estuary with the daily tides (Horne and Goldman 1994; Wallace 1998; Hiner 2006). The salt water wedge results in thermal stratification of the estuary with cooler, high salinity ocean waters remaining near the estuary bottom, and warmer, low salinity river water near the surface. Under low-flow summertime conditions, when the mouth can close, surface water temperatures in the estuary have been observed at 64.4–76.5°F (Wallace 1998; Hiner 2006; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016). Input of cool ocean water and fog along the coast minimizes extreme water temperatures much of the time (Scheiff and Zedonis 2011).

[23] The average daily maximum water temperature is calculated by determining the daily maximum water temperature for each day with at least 80 percent complete data (38 out of 48 individual 30-minute measurements present), then averaging the daily maximum water temperature for each day from 2001 to 2011.
[24] Chronic (sub-lethal) effects temperature thresholds are detailed in Appendix 4 of North Coast Regional Board (2010).

3.2.2.3 Suspended Sediments

For the purposes of the Lower Klamath Project EIR, "suspended sediment" refers to settleable suspended material in the water column. Bed materials, such as gravels and larger substrates, are discussed in Section 3.11.2.4 *Sediment Load*. Two types of suspended material are important to water quality in the Klamath River: algal-derived (organic) suspended material and mineral (inorganic) suspended material. Sources of each type of suspended material differ, as do spatial and temporal trends for each, within the Upper, Middle, and Lower Klamath river reaches.

Suspended material concentrations tend to decrease through the Hydroelectric Reach (PacifiCorp 2004b), where interception, decomposition, and retention of organic suspended materials occur in the Lower Klamath Project reservoirs. Additionally, dilution from coldwater springs below J.C. Boyle assists in decreasing organic suspended material concentrations. However, seasonal increases in organic suspended material can occur in Copco No. 1 and Iron Gate reservoirs due to large summertime phytoplankton blooms, which can adversely affect water quality beneficial uses (PacifiCorp 2004b; Raymond 2008a, 2009a, 2010a; Watercourse Engineering, Inc. 2011b, 2012, 2013, 2014, 2015, 2016) (see Appendix C, Section C.2.1 for more detail).

In the winter months, suspended material in the Hydroelectric Reach is dominated by mineral sediment loads from several tributaries that join the river in this reach (primarily Shovel Creek, Spencer Creek, Jenny Creek, Fall Creek). Inorganic suspended materials (i.e., silts, clays with diameters less than 0.063 mm) are primarily transported during high flow events and generally settle out in the Lower Klamath Project reservoirs such that water column concentrations decrease with distance downstream in this reach (see also Appendix C, Section C.2.1). Likewise, the reservoirs trap bedload or fluvial sediment (coarse sand, gravels, and larger materials with diameters greater than 0.063 mm) from the tributaries. On the scale of the entire Klamath Basin, the trapping of fine sediments and suspended materials does not appear to be a critical function of the Lower Klamath Project reservoirs with respect to the overall cumulative sediment delivery including downstream tributaries (see also Section 3.11.2.4 Sediment Load), since a relatively small percentage (3.4 percent) of total sediment supplied to the Klamath River on an annual basis originates from the Upper and Middle Klamath River (i.e., from J.C. Boyle Dam to the confluence with the Shasta River). Beneficial uses in the Hydroelectric Reach are currently not impaired due to inorganic suspended material (North Coast Regional Board 2011).

Just downstream from Iron Gate Dam (RM 193.1), inorganic suspended material concentrations are generally low. However, in the summer months, organic suspended materials can increase in the Klamath River between Iron Gate Dam and Seiad Valley (RM 132.7) due to the transport of in-reservoir algal blooms to downstream reaches of Klamath River as well as resuspension of previously settled organic materials (YTEP 2005; Sinnott 2008; Armstrong and Ward 2008; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016). Further downstream, near the confluence with the Scott River (RM 145.1) concentrations of organic suspended materials tend to decrease with distance as phytoplankton gradually settle out of the water column farther downstream or are diluted by tributary inputs (see Appendix C for more detail).

Inorganic suspended sediments downstream of Iron Gate are mainly contributed by major tributaries to the mainstem during winter and spring (Armstrong and Ward 2008). The three tributaries that contribute the largest amount of suspended sediment to the Klamath River are located below Iron Gate Dam and include: the Scott River (RM 145.1) (607,300 tons per year or 10 percent of the cumulative average annual delivery from the basin); Salmon River (RM 66) (320,600 tons per year or 5.5 percent of the cumulative average annual delivery from the basin) (Stillwater Sciences 2010); and, the Trinity River (3,317,300 tons per year or 57 percent of the cumulative average annual delivery from the basin) (Stillwater Sciences 2010) (see Appendix C for more detail). Additionally, steep terrain and land use activities such as timber harvest and road construction near the Klamath River and its tributaries result in high sediment loads during high-flow periods.

3.2.2.4 Nutrients

Levels of nutrients, including nitrogen and phosphorus, are affected by the geology of the Klamath Basin, upland productivity and land uses, and a number of physical processes affecting aquatic productivity within reservoir and riverine reaches. The two major upstream sources of nutrients to the water quality Area of Analysis are Upper Klamath Lake, which inputs nitrogen and phosphorus (Kann and Walker 1999; ODEQ 2002; PacifiCorp 2004b; Deas and Vaughn 2006; FERC 2007; Sullivan et al. 2008; Asarian et al. 2010) and the Lost River Basin (via the Klamath Straits Drain and the Lost River Diversion Channel), which inputs nutrients and organic matter (Lytle 2000; Mayer 2005; Sullivan et al. 2009; Sullivan et al. 2011; Kirk et al. 2010).

On an *annual* basis, nutrients typically decrease slightly through the Hydroelectric Reach due to settling of particulate matter and associated nutrients in Copco No. 1 and Iron Gate reservoirs, and dilution by the coldwater springs located downstream of J.C. Boyle Reservoir (Asarian et al. 2010; North Coast Regional Board 2010; Oliver et al. 2014)[25]. However, on a *seasonal* basis, total phosphorus (TP), and to a lesser degree total nitrogen (TN), can increase in the Hydroelectric Reach due to the release (export) of dissolved forms of phosphorus (ortho-phosphorus) and nitrogen (ammonium) from reservoir sediments during summer and fall when reservoir bottom waters are anoxic (Kier Associates 2006; Kann and Asarian 2007; Stillwater Sciences 2009; Asarian et al. 2010; Oliver et al. 2014) (see Appendix C for additional details). Seasonal nutrient releases occur during periods of in-reservoir phytoplankton growth, and, in the case of TP, can also result in downstream transport of bioavailable nutrients to the Lower Klamath River where they can stimulate excessive growth of periphyton (aquatic freshwater organisms attached to river bottom surfaces). Additional information on effects of the Lower Klamath Project to phytoplankton and periphyton can be found in Section 3.4 *Phytoplankton and Periphyton*.

Seasonal variations in concentrations of TN and TP occur in the Klamath River downstream of Iron Gate Dam, due to a combination of nutrient storage and release from the water column and reservoir sediments, varying water concentrations at the elevation of the penstock intakes, residence times, and possible atmospheric losses through denitrification (for TN only) (Asarian and Kann 2011). In the summer and fall,

[25] The total nitrogen (TN) and total phosphorus (TP) nutrient concentrations in the natural coldwater springs are low, at approximately 0.22 mg/L TN (almost exclusively dissolved) and 0.06–0.08 mg/L TP (mostly dissolved) (Asarian et al. 2010).

TN and TP loads from Iron Gate Reservoir dominate nutrient loading to the Lower Klamath River compared to inputs from downstream tributaries, because tributary flows are relatively low during these seasons (Armstrong and Ward 2008). Downstream from the Lower Klamath Project, TP values typically range 0.1–0.25 milligrams per liter (mg/L) in the Klamath River between Iron Gate Dam and Seiad Valley, with the highest values occurring just downstream from the dam. TN concentrations in the river downstream from Iron Gate Dam generally range from less than 0.1 to over 2.0 mg/L and are generally lower than those in upstream reaches due to reservoir retention and dilution by springs in the Hydroelectric Reach (Asarian et al. 2009) (see Appendix C for additional details). TP and TN concentrations in the Klamath River vary with flow, with the highest concentrations tending to occur during low flow years (e.g., 2001-2004) and the lowest concentrations tending to occur during high flow years (e.g., 2006, 2010, 2011) (Asarian and Kann 2013). Dissolved nitrogen (nitrate) shows substantial variability among years (Asarian and Kann 2013).

Further variations in TN occur in the Middle and Lower Klamath river reaches due to a combination of tributary dilution and in-river nutrient spiraling processes by phytoplankton and periphyton. Nutrient concentrations are generally much lower in tributaries, with the exception of TP, TN, and soluble reactive phosphorus in the Shasta River and TN and nitrate in the Scott River at the outlet of Scott Valley (Asarian and Kann 2013). In-river nutrient spiraling processes by phytoplankton and periphyton involve cycling of nutrients by uptake during growth, storage in biomass, and release during biomass decay. These nutrient spiraling processes strongly affect nitrogen concentrations in flowing rivers. Removal processes such as denitrification and/or assimilation and storage related to biomass uptake decrease dissolved nitrogen concentrations in the river (Mulholland 1996; Butcher 2008; Asarian et al. 2010; Asarian and Kann 2013). Late-seasonal recycling of nutrients downstream occurs as active phytoplankton and periphyton growth wanes and may result in more bioavailable nutrients in the river. Ratios of nitrogen to phosphorus (TN:TP) measured in the Klamath River downstream from Iron Gate Dam suggest the potential for nitrogen-limitation of primary productivity[26] (i.e., phytoplankton and/or periphyton growth) with some periods of co-limitation by both nitrogen and phosphorus. However, concentrations of both nutrients are high enough that other factors (i.e., light, water velocity, or available substrate) may be more limiting to phytoplankton and periphyton growth than nutrients are, particularly in the vicinity of Iron Gate Dam (FERC 2007; HVTEPA 2008; Asarian et al. 2010) (see Appendix C and Section 3.4 *Phytoplankton and Periphyton* for additional details).

Downstream from the confluence with the Salmon River, nutrient concentrations continue to decrease in the Klamath River due to tributary dilution and nutrient retention. Contemporary data (2001–2015) indicate that TP concentrations in this portion of the river are generally 0.05–0.1 mg/L with peak values occurring in September and October. Contemporary data indicate that, on a seasonal basis, TN increases from May through November with peak concentrations (greater than 0.5 mg/L) typically observed between August and October (YTEP 2004a, 2005; Sinnott 2008, 2009a, 2009b, 2010b, 2011b, 2012b; Asarian et al. 2010; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Asarian and Kann 2013; HVTEPA 2013; Hanington and Torso 2013; Hanington and Stawasz 2014; Hanington and Cooper-Carouseli 2014; Oliver et al.

[26] Primary productivity is the synthesis of organic compounds by organisms through either photosynthesis or chemosynthesis.

2014). Under these existing conditions, both TP and TN are at or above the Hoopa Valley Tribe numeric criterion of 0.2 mg/L TN and 0.035 mg/L TP (HVTEPA 2008).

Nutrient levels in the Klamath River Estuary experience inter-annual and seasonal variability. Measured levels of TP in the estuary are typically below 0.1 mg/L during summer and fall (June–October) and TN levels are consistently below 0.7 mg/L (June–October) (Sinnott 2008, 2009a, 2009b, 2010b, 2011b, 2012b; Hanington and Torso 2013; Hanington and Stawasz 2014; Hanington and Cooper-Carouseli 2014). While the Basin Plan water quality objective for biostimulatory substances is narrative rather than numeric (North Coast Regional Board 2011), as with upstream reaches, measured nutrient levels in the Klamath River Estuary may, at times, promote algal growth at levels that cause nuisance effects or adversely affect beneficial uses.

3.2.2.5 Dissolved Oxygen

Dissolved oxygen is the amount of oxygen gas dissolved in water. Oxygen enters water by direct incorporation from the atmosphere, through rapid mixing of water with air (e.g., turbulent mixing in fast flowing stream reaches), or as a waste product of photosynthesis by aquatic organisms. Water temperature and the volume of moving water can influence dissolved oxygen concentrations in water. Dissolved oxygen concentrations in the Klamath River depend on several factors, including water temperature (colder water absorbs more oxygen), water depth and volume, stream velocity (as related to mixing and re-aeration), atmospheric pressure, salinity, and the activity of organisms that depend upon dissolved oxygen for respiration. This last factor (respiratory consumption) is strongly influenced by the availability of nitrogen and phosphorus for supporting algal and aquatic plant growth.

During summer, the Lower Klamath Project reservoirs' surface waters exhibit varying levels of dissolved oxygen mainly driven by blue-green algae blooms in the reservoirs. During daylight hours, blue-green algae produce dissolved oxygen (through photosynthesis), resulting in super-saturation of dissolved oxygen. During nighttime hours, blue-green algae consume dissolved oxygen (through respiration) contributing to dissolved oxygen levels that can be below Basin Plan objectives.

The relatively long and shallow J.C. Boyle Reservoir (in Oregon) does not thermally stratify (see also Section 3.2.2.2 *Water Temperature*). While reaeration in the steep gradient of the Upper Klamath River between Keno Dam and J.C. Boyle Reservoir can increase dissolved oxygen in the Klamath River to near saturation levels, high biological oxygen demand in water entering J.C. Boyle during summer months can still reduce dissolved oxygen levels as the water slows in the relatively low gradient of the reservoir (Raymond 2008a, 2009a, 2010a). While J.C. Boyle Reservoir does not thermally stratify, there are still large summertime variations in dissolved oxygen with depth observed in J.C. Boyle Reservoir that result in bottom waters in the reservoir having lower dissolved oxygen concentrations than surface waters (Raymond 2009a, 2010a; see Appendix C, Figure C-29 for more detail). This variation can affect dissolved oxygen concentrations further downstream in the California portion of the Hydroelectric Reach.

Copco No. 1 and Iron Gate reservoirs thermally stratify beginning in April/May and do not mix again until October/November (FERC 2007). During summer months, dissolved oxygen in Copco No. 1 and Iron Gate in the layer of water at the surface (epilimnion) is generally at, or in some cases above, saturation, while levels in hypolimnetic waters (the layer at the bottom) reach minimum values near 0 mg/L by July (see Appendix C for more detail). While minimum surface dissolved oxygen concentrations generally co-occur with maximum water temperatures in July and August, the lowest surface dissolved oxygen concentrations tend to occur in October in Iron Gate Reservoir (see Appendix C, Figure C-32) (Raymond 2009a, 2010a; Asarian and Kann 2011). The low surface dissolved oxygen levels and their occurrence later in the season at Iron Gate Reservoir is believed to be associated with seasonal algal blooms, as dead algal cells are decomposed by aerobic organisms, exhausting dissolved oxygen in reservoir bottom waters and sediments (Asarian and Kann 2013).

In addition to the biological oxygen demand of the water column, there is also a sediment oxygen demand that influences dissolved oxygen levels in the water column of lakes, reservoirs, and rivers (Doyle and Lynch 2005). Sediment oxygen demand is the rate at which dissolved oxygen is removed from the water column by the decomposition of organic matter in streambed or lake/reservoir sediments. An analysis of oxygen demand in sediment cores sampled in 2002 from Copco No. 1 and Iron Gate reservoirs indicates that sediment oxygen demand in these waterbodies ranges from 1.0 to 2.0 grams of oxygen per square meter per day (g O_2/m^2/day) (FERC 2007), which is on the high end of values measured in other California reservoirs that typically range from approximately 0.1 g O_2/m^2/day to 1.4 g O_2/m^2/day (Beutel 2003).

Based upon measurements collected in the Middle Klamath River immediately downstream from Iron Gate Dam, dissolved oxygen concentrations in this location regularly fall below 8.0 mg/L[27] and the Basin Plan minimum dissolved oxygen criteria of 85 to 90 percent saturation (depending on season and location) (Karuk Tribe of California 2001, 2002, 2003, 2007, 2009, 2010a, 2010b, 2011, 2012, 2013; Asarian and Kann 2011, 2013; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016). Daily fluctuations in dissolved oxygen (ranging from 1 to 3 mg/L per day) measured in the Klamath River immediately downstream from Iron Gate Dam have been attributed to daytime algal photosynthesis and nighttime bacterial respiration in the upstream reservoirs (Karuk Tribe of California 2002, 2003; YTEP 2005; North Coast Regional Board 2010; Asarian and Kann 2011, 2013). Although PacifiCorp has operated a turbine venting system since 2010 that mechanically adds oxygen to water as it is passed through the powerhouse turbines and before it is discharged to the Middle Klamath River, low dissolved oxygen saturation values continue to occur immediately downstream of the dam during late summer through fall (August through November) every year (PacifiCorp 2013, 2014, 2014, 2015, 2016, 2017, Karuk Tribe of California 2012, 2013).

Farther downstream in the mainstem Klamath River, near Seiad Valley, dissolved oxygen concentrations tend to be higher but variable, with mean daily values ranging from approximately 6.5 mg/L to supersaturated concentrations of approximately 11.5 mg/L from June through November (Karuk Tribe of California 2001, 2002, 2003, 2007, 2009, 2010a, 2010b, 2011, 2012, 2013; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016). At Seiad Valley, 31 percent of dissolved oxygen continuous data showed less than 8.0 mg/L between June and October during 2001 to 2011. During this period, the dissolved oxygen concentrations were less than 90 percent saturation in 25 percent of the continuous data and less than 85 percent

[27] The Hoopa Valley Tribe surface-water quality objective for dissolved oxygen for COLD beneficial use is 8.0 mg/L (see Table 3.2-7).

saturation in 9 percent of measurements (Asarian and Kann 2013). Longitudinal variations in dissolved oxygen from Iron Gate Dam to Seiad Valley are most pronounced in the fall when dissolved oxygen concentrations are low immediately downstream of Iron Gate Dam and increase to saturation (or supersaturation) by Seiad Valley (Karuk Tribe of California 2013).

Dissolved oxygen concentrations from Orleans to Turwar in the Klamath River are also variable, with typical daily values ranging from approximately 6.5 mg/L to supersaturated concentrations of 11.5 mg/L during summer through fall (Karuk Tribe of California 2001, 2002, 2003, 2007, 2009, 2010a, 2010b, 2011, 2012, 2013; Ward and Armstrong 2010; North Coast Regional Board 2010; Asarian and Kann 2011, 2013; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016). Near the confluence with the Trinity River and at Turwar, diel fluctuations in dissolved oxygen concentrations were observed resulting in dissolved oxygen greater than 8.0 mg/L during part of the day, but dissolved oxygen below 8.0 mg/L for several hours on multiple consecutive days to weeks during late summer/early fall (YTEP 2005; Sinnott 2010a, 2011a, 2012a; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015; Asarian and Kann 2013; Hanington 2013; Hanington and Ellien 2013) (see Appendix C for additional details).

Dissolved oxygen concentrations in the Klamath River Estuary vary both temporally and spatially; concentrations in the deeper main channel of the estuary are generally greater than 6 to 7 mg/L throughout the year (Hiner 2006, YTEP 2005). Low dissolved oxygen concentrations (less than 1 to 5 mg/L) have been observed during summer months in the relatively shallow, heavily vegetated south slough (Hiner 2006, Wallace 1998). The low levels of dissolved oxygen observed in the slough are likely due to high rates of growth and subsequent decomposition of algae and macrophytes, which are not abundant elsewhere in the estuary. Data during the period of 2009−2015 in the lower Klamath River Estuary (approximately RM 0.5) indicate that dissolved oxygen usually ranges from 7 mg/L to supersaturated concentrations of approximately 11 mg/L during summer and fall, with minimum levels near 5 mg/L (Sinnott 2010a, 2011a, 2012a; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015; Hanington 2013; Hanington and Ellien 2013; Hanington and Cooper-Carouseli 2014) (see Appendix C for additional details).

3.2.2.6 pH

The pH of surface water is controlled by atmospheric carbon dioxide as well as the photosynthetic and respiratory processes of organisms in the water. pH controls the form that some chemical compounds take and mediates the chemical speciation of other compounds in the water (e.g., ammonia/ammonium, minerals, metals). In addition, pH influences the concentration of un-ionized ammonia and the ammonium ion in the water column (North Coast Regional Board 2010). The ability of a system to buffer changes in pH from natural and anthropogenic sources is measured by the total alkalinity of the water. Typical alkalinity of freshwater ranges from 20 to 200 mg/L, with levels below 100 mg/L indicating limited buffering capacity and an increased susceptibility to changes in pH. Levels below 10 mg/L indicate that the system is poorly buffered and very susceptible to changes in pH (Stillwater Sciences 2009).

The Klamath River is a weakly buffered system (i.e., has typically low alkalinity less than 100 mg/L as calcium carbonate [$CaCO_3$]; PacifiCorp [2004a], Karuk Tribe of California

[2010a]), so it is susceptible to photosynthesis-driven daily and seasonal swings in pH. In the Hydroelectric Reach, pH varies with both depth in the reservoirs and season, as changes in rates of photosynthesis and respiration alter pH of the water. Vertical profile measurements of pH in Iron Gate and Copco No. 1 reservoirs between March and November 2000−2005 and June through November 2007 indicate that pH decreases with depth in both reservoirs (Figure 3.2-4; see Appendix C for additional details). The vertical distribution of pH values in both Lower Klamath Project reservoirs is attributed to photosynthesis of floating phytoplankton in surface waters (which increases pH) and respiration in bottom waters (which decreases pH) (Raymond 2008a; Asarian and Kann 2011). The dissolved oxygen vertical profiles in the Lower Klamath Project reservoirs further supports the role of phytoplankton in influencing pH with supersaturated dissolved oxygen concentrations in surface waters from photosynthesis and low dissolved oxygen in bottom waters from respiration (Figure 3.2-4).

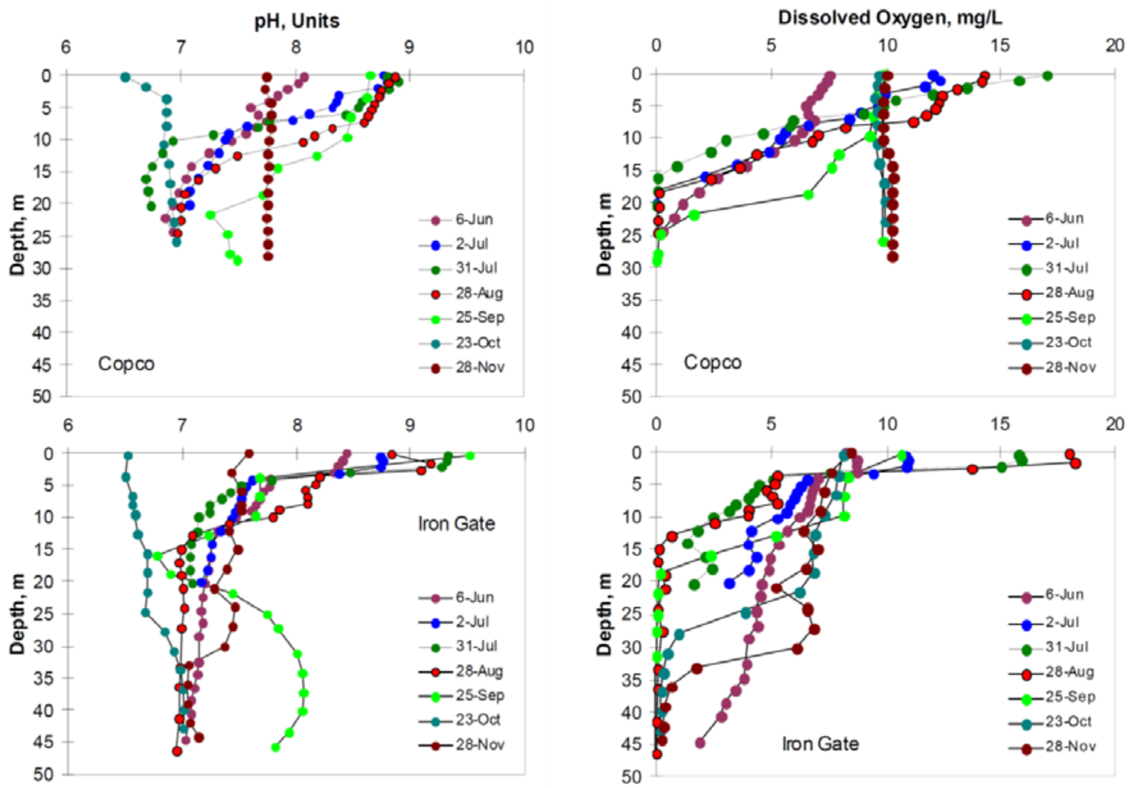

Figure 3.2-4. Vertical Profiles of pH and Dissolved Oxygen Measured During 2007 in Copco No 1. Reservoir at the Log Boom (top plot) and Iron Gate Reservoir at the Log Boom (bottom plot). Source: Adapted from Raymond 2008a.

Approximately 30 percent of samples collected in Copco No. 1 Reservoir and 5 to 20 percent of samples[28] collected in Iron Gate Reservoir surface waters (here, less than

[28] PacifiCorp (2008) Table 5.2-11 specifies the number of samples with pH greater than 8.5 as 25 of 485 total samples, equating to approximately 5 percent of samples. However, the table lists the percent of samples with pH greater than 8.5 as 19.6 percent. This appears to be a typographical error that cannot be resolved with the available information in PacifiCorp (2008).

eight meters deep) exhibited pH values greater than 8.5 standard units (s.u.) (PacifiCorp 2008), which is the Basin Plan instantaneous maximum pH objective (North Coast Regional Board 2011). In contrast, pH samples collected in bottom waters (here, greater than 20 meters) of both reservoirs tend to be lower, with approximately 17 percent of samples (68 of 391) collected in Copco No. 1 Reservoir and 22 percent of samples (135 of 613) collected in Iron Gate Reservoir exhibiting pH values less than 7.0 s.u. Other studies document peak pH values (8.5 to 9.2 s.u.) near the reservoir surfaces during summer months (Raymond 2010a; Watercourse Engineering, Inc. 2012, 2013, 2014, 2015, 2016), while lower values (5.4 to 8.0 s.u.) have been documented near reservoir bottoms, without a consistent temporal trend amongst the reservoirs. Longitudinally within the Hydroelectric Reach, the lowest pH values have been recorded downstream from J.C. Boyle Reservoir (in Oregon) and the highest values in Copco No. 1 and Iron Gate reservoirs (Raymond 2008a, 2009a, 2010a).

In the Middle Klamath River, there are seasonally high pH values , with the highest pH values generally occurring during late-summer and early-fall months. Daily cycles in pH also occur in these reaches, with pH usually peaking during later afternoon or early evening following the period of maximum photosynthesis (North Coast Regional Board 2010, Asarian and Kann 2013). The daily range of pH (i.e., daily maximum pH minus daily minimum pH) generally peaks between late July and early September, corresponding to daily cycles of photosynthesis and respiration, which also peak between late July and early September (Asarian and Kann 2013). The Basin Plan instantaneous maximum pH objective of 8.5 s.u. is regularly exceeded in the Middle and Lower Klamath River (FISHPRO 2000; Karuk Tribe of California 2002, 2003; YTEP 2005; FERC 2007; USFWS 2008; North Coast Regional Board 2010, 2011; Asarian and Kann 2013; Watercourse Engineering, Inc. 2012, 2013, 2014, 2015, 2016) (see Appendix C for more detail). The most extreme pH exceedances typically occur from Iron Gate Dam to approximately Seiad Valley, with pH values generally decreasing with distance downstream (FERC 2007; Karuk Tribe of California 2007, 2009, 2010a, 2010b, 2011, 2012, 2013; Asarian and Kann 2013) (see Appendix C for more detail). Analysis of data from 2001 to 2011 indicates that for June through October, 35 percent of pH measurements exceeded 8.5 s.u. between Iron Gate Dam and the confluence with the Shasta River, and 11 percent of pH measurements exceeded 8.5. s.u. at Orleans. pH greater than 9.0 s.u. was most frequently recorded at Iron Gate Dam (nine percent for September) and was rare (less than 0.1 percent) at mainstem locations below Seiad Valley (Asarian and Kann 2013).

During the summer months, pH values also are elevated in the Lower Klamath River from the confluence with the Trinity River downstream to approximately Turwar Creek (FISHPRO 2000; Karuk Tribe of California 2002, 2003, 2007, 2009, 2010a, 2010b, 2011, 2012, 2013; YTEP 2005; USFWS 2008; North Coast Regional Board 2010, 2011; Sinnott 2010a, 2011a, 2012a; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Asarian and Kann 2013) (see Appendix C for more detail). In the Klamath River Estuary, pH ranges between approximately 6.9 and 9.0 s.u. with peak values also occurring during the summer months, though values below 6.9 s.u. have occasionally been measured (YTEP 2005; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016). Daily variations in pH are typically on the order of 0.5 s.u., and fluctuations tend to be somewhat larger in the late summer and early fall. When large daily fluctuations are observed, they are likely caused by algal blooms that are transported into the estuary (YTEP 2005).

3.2.2.7 Chlorophyll-*a* and Algal Toxins

As primary producers, phytoplankton and periphyton are critical components of river and lake ecosystems (see also Section 3.4 *Phytoplankton and Periphyton*). Their presence and abundance affect food web dynamics as well as physical water quality parameters (e.g., dissolved oxygen, pH, turbidity, and nutrients). Physical water quality parameters are affected by phytoplankton and periphyton through rates of photosynthesis, respiration, and decay of dead phytoplankton and periphyton cells (Horne and Goldman 1994). Phytoplankton and periphyton species in the water quality Area of Analysis include a number of different species that may have very different effects on water quality and water chemistry. With respect to phytoplankton, a 2007 field study from Upper Klamath Lake to the Klamath River at Turwar found that the major groups present include diatoms (70 percent of total biovolume), cyanobacteria [blue-green algae] (28 percent of total biovolume), and green algae (1 percent of total biovolume) (Raymond 2008b). Diatoms (i.e., unicellular, photosynthetic microalgae) typically dominate in spring then decrease due to zooplankton[29] grazing and the onset of water column stratification, which results in the diatoms settling out of the water column below the lake or reservoir surface layer (epilimnion). Cyanobacteria, also referred to as "blue-green algae," are photosynthetic bacteria and can often be a nuisance aquatic species, occurring as large seasonal blooms that alter surrounding water quality. Blue-green algae dominance increases during late summer and early fall because their ability to control their buoyancy which enables blue-green algae to remain near the surface during lake or reservoir stratification, thereby obtaining light for photosynthesis better than diatoms (Raymond 2008b, 2009b, 2010b; Asarian and Kann 2011; McDonald and Lehman 2013; Visser et al. 2016). Dense blooms of blue-green algae that can remain at the water surface also reduce the light available for photosynthesis and growth of other phytoplankton species, like diatoms and green algae, that cannot control their buoyancy (Miller et al. 2010).

Some blue-green algae species produce algal toxins, which are also referred to as cyanotoxins (e.g., cyclic peptide toxins such as microcystin that act on the liver, alkaloid toxins such as anatoxin-a and saxitoxin that act on the nervous system). Cyanotoxins can cause irritation, sickness, or, in extreme cases, death to exposed organisms, including humans (WHO 1999). Incidence of visual disturbance, nausea, vomiting, muscle weakness, and acute liver failure have been reported in humans exposed to algal toxins (OEHHA 2012). For example, four hours of recreational water exposure to 48.6 micrograms per liter (ug/L) of microcystin (one of the more common algal toxins found in Iron Gate and Copco reservoirs) is documented to cause abdominal pain, headache, sore throat, vomiting, nausea, dry cough, diarrhea, blistering around the mouth, and pneumonia (USEPA 2015). The California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network, a multi-agency workgroup formerly called the Statewide Blue-Green Algae Working Group, has developed guidance for responding to harmful algal blooms (HABs), cyanotoxin (algal toxin) threshold levels for protection of human health, and cyanotoxin posting requirements for recreational waters (State Water Board et al. 2010, updated 2016). Species present in the Klamath River capable of producing microcystin include *Microcystis aeruginosa* and *Anabaena flos-aquae*[30], while species

[29] Heterotrophic plankton that prey on diatoms

[30] While *Anabaena flos-aquae* are capable of producing microcystin (Lopez et al. 2008), it is widely assumed that detected concentrations of microcystin are due to *Microcystis aeruginosa* rather than *Anabaena flos-aquae* due to the lower abundance of *Anabaena flos-aquae* compared

present in the Klamath River in the genus *Anabaena* can produce anatoxin-a and saxitoxin. More complete listings of specific toxins produced by genera of blue-green algae worldwide are provided in Lopez et al. (2008) and ODEQ (2011).

For microcystin specifically, thresholds in drinking water or recreational waters for the protection of human health have been developed primarily using the results of animal studies (USEPA 2015). The State Water Board, California Department of Public Health (CDPH), and California Environmental Protection Agency's (CalEPA) Office of Environmental Health and Hazard Assessment (OEHHA) "Caution Action" posting threshold for the protection of human health in recreational waters is 0.8 micrograms per liter (ug/L) of microcystin (State Water Board et al. 2010, updated 2016).

Additional discussion of algal species, including algae suspended in the water column (phytoplankton) and algae attached to bottom sediments or channel substrate (periphyton), is provided in Section 3.4 *Phytoplankton and Periphyton*.

Chlorophyll-*a*, a pigment produced by photosynthetic organisms, is often used as a surrogate measure of algal biomass. Historically, seasonal algal blooms and elevated chlorophyll-*a* concentrations have been observed in the Hydroelectric Reach, including a 1975 survey in Iron Gate Reservoir documenting algal blooms in March, July, and October, including diatoms and blue green algae (USEPA 1978). More contemporary data indicate that chlorophyll-*a* levels in Copco No. 1 and Iron Gate reservoirs can be two to ten times greater than those in the mainstem Klamath River (Flint et al. 2005; Kann and Corum 2009; North Coast Regional Board 2010; Asarian and Kann 2011; Watercourse Engineering, Inc. 2016) (Figure 3.2-25; see Appendix C for more detail).

to *Microcystis aeruginosa*. The relative proportion of microcystin contributions from *Anabaena flos-aquae* versus *Microcystis aeruginosa* has not been documented for the Klamath Basin.

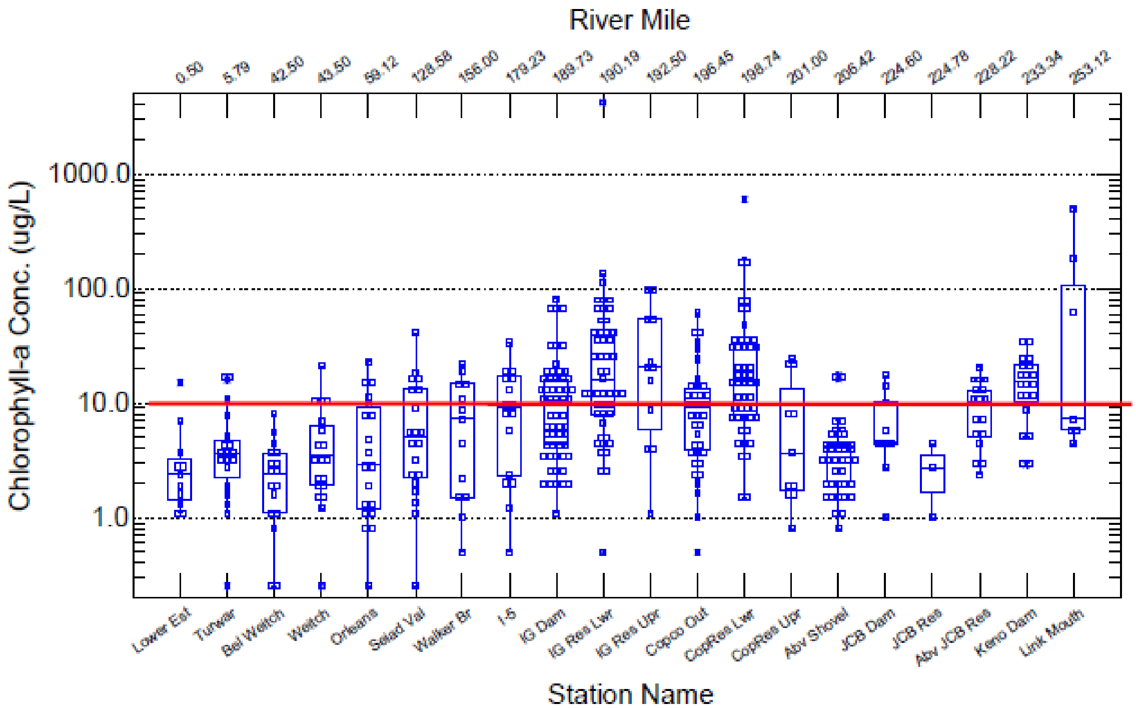

Figure 3.2-5. Longitudinal Analysis of Summer (May through September) Chlorophyll-*a* Concentrations from 2005–2007 Along the Klamath River. Note the Logarithmic Scale. Data from the Yurok Tribe, Karuk Tribe, North Coast Regional Water Quality Control Board, and PacifiCorp. Source: North Coast Regional Board 2010.

Summer and early fall chlorophyll-*a* measurements for the period 2005−2010 show higher concentrations in Copco No. 1 and Iron Gate reservoirs compared to the Hydroelectric Reach upstream of Copco No. 1, between the reservoirs, or below Iron Gate Dam. Chlorophyll-*a* concentrations are generally higher at the reservoir surface and decrease with depth in the reservoir. Peak chlorophyll-*a* concentrations during algal blooms are generally higher in Copco No. 1 Reservoir than in Iron Gate Reservoir, with some exceptions (Asarian and Kann 2011). Overall, chlorophyll-*a* in the Klamath River tends to decrease downstream of Iron Gate Dam, but concentrations can occasionally remain approximately the same or increase during intense algal blooms in Iron Gate and Copco No. 1 reservoirs (Ward and Armstrong 2010; Asarian and Kann 2013; Watercourse Engineering, Inc. 2013, 2014, 2015, 2016). Chlorophyll-*a* concentrations downstream of Iron Gate Dam also exhibit seasonal variation, with concentrations increasing in summer months and decreasing in fall and winter (Asarian and Kann 2013) (see Appendix C for additional details). Chlorophyll-*a* concentrations downstream of Iron Gate Dam tend to be low during winter months (Asarian and Kann 2011). Phycocyanin, a pigment produced by blue-green algae, has been collected between May and November at some monitoring sites in the Klamath River downstream of Iron Gate Dam since 2007. At Seiad Valley (RM 132.7), phycocyanin is typically low from May through early August, increases to a peak in early September, and decreases until reaching low levels again by the end of October (Asarian and Kann 2013). Phycocyanin concentrations generally coincide with chlorophyll-a concentrations for the portion of the Klamath River at Seiad Valley.

High levels of the cyanotoxin microcystin occur during summer months in Copco No. 1 and Iron Gate reservoirs (Kann and Corum 2009; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Otten et al. 2015). In Copco No. 1 Reservoir, peak microcystin concentrations between 2006 and 2015 exceeded the CCHAB (2010, updated 2016) 0.8 ug/L threshold for the protection of human health in recreational waters by over 10,000 times. Watercourse Engineering (2011a) found extremely high concentrations (1,000–73,000 ug/L) during summer algal blooms in both Copco No. 1 and Iron Gate reservoirs during 2009 (see Appendix C for more detail). Consistent with previous findings, public health sampling data from 2015 show microcystin peaking between 12,000 and 16,000 ug/L in Copco No. 1 Reservoir during algal blooms in the summer and microcystin peaking from 64 to 770 ug/L in Iron Gate Reservoir (Watercourse Engineering, Inc. 2016). Microcystin concentrations are generally low from J.C. Boyle Reservoir to Copco No. 1 Reservoir, higher between Copco No. 1 Reservoir and Iron Gate Reservoir, and then generally decrease with distance downstream from Iron Gate Reservoir (Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016).

Microcystin concentrations downstream of Iron Gate Dam to the Klamath River Estuary are spatially and temporally variable (see Appendix C for more detail). The longitudinal and temporal variations in microcystin concentrations from upstream of Copco No. 1 Reservoir to Turwar indicate that Iron Gate Reservoir is the principal source of *Microcystis aeruginosa* cells to the Middle and Lower Klamath River (Otten et al. 2015). The timing of peak microcystin concentrations in Iron Gate Reservoir corresponds to peak concentrations in the Klamath River downstream of Iron Gate Dam, consistent with the reservoir as the source (Otten et al. 2015).

Baseline monitoring for potential risk to public health from microcystin toxins was established in 2008. Public health monitoring within the Copco No. 1 and Iron Gate reservoirs and along the mainstem of the Klamath River is conducted collaboratively by PacifiCorp, Karuk Tribe, and Yurok Tribe. Monitoring occurs at various intervals from May through November. If river conditions exceed public health standards for toxic algae the area is posted with a health advisory sign.

Guidelines for posting health advisories have varied since 2008 and currently are provided by the State Water Board et al. (2010, updated 2016) for water in California. SWRCB posting levels are listed as Caution, Warning, and Danger at microcystin concentrations of 0.8, 6, and 20 ug/L, respectively, with toxin producing cells densities greater than 4,000 cells/mL, or "blooms, scums, or mats", resulting in posting at the Caution level.

The Karuk Tribe (Kann 2014) and Yurok Tribe (YTEP 2016) each adopted public health guidelines for recreational waters at levels equal to or more stringent than those adopted by the State Water Board. Annual results from baseline monitoring programs along used to determine postings of public health advisories are compiled by Klamath Basin Monitoring Program (KBMP) and used to inform the Blue Green Algae Tracker available on the KBMP website (www.kbmp.net).

Microcystin can also bioaccumulate in aquatic biota. During July through September 2007, 85 percent of fish and mussel tissue samples collected from the Klamath River, including samples from Iron Gate and Copco No. 1 reservoirs, exhibited microcystin bioaccumulation, with the total microcystin congeners ranging from less than detection levels to 2,803 ng/g (Kann 2008a). The levels of microcystin bioaccumulation measured in 2007 exceeded the public health guidelines defined by Ibelings and Chorus (2007), indicating ingestion of the fish or mussels would potentially pose a health hazard to humans (Kann 2008a). In 2010, algal toxins were found in salmonid tissues collected from the Middle Klamath River near Happy Camp (Kann et al. 2013). In contrast, data from 2008 and 2009 did not show microcystin bioaccumulation in the tissue and liver samples from fish collected from Copco No. 1 and Iron Gate reservoirs (CH2M Hill 2009; PacifiCorp 2010). Estuarine and marine nearshore effects (e.g., sea otter deaths) from blue-green algae exposure have been reported in other California waters; however, none have been documented to date for the Klamath River Estuary or marine nearshore (Miller et al. 2010). Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project − Algal Toxins* presents a discussion of algal toxins as related to fish health.

Anatoxin-a produced by the genus *Anabaena* of blue-green algae species was detected in Iron Gate Reservoir on September 3, 2005, in testing by the California Department of Health Services (Kann 2007a; Kann 2008b). In additional, monitoring conducted for the Karuk Tribe during 2005, 2006, 2007, 2008 in Copco No. 1 or Iron Gate reservoirs found no anatoxin-a detected (Kann and Corum 2006, 2007, 2009; Kann 2007b). At Lower Klamath River monitoring sites, anatoxin-a was not detected above the reporting limit in water samples collected during 2008 and 2009 (Fetcho 2009, 2011). In recent years, anatoxin-a has been measured in the Klamath River downstream of Iron Gate Reservoir on several occasions, typically in the lower reaches including at monitoring sites near Weitchpec and Orleans (Otten 2017). While concentrations of *Anabaena flos-aquae* cells have continued to be monitored, anatoxin-a concentrations are not available for Lower Klamath Project reservoir and Klamath River sites in recent years.

3.2.2.8 Inorganic and Organic Contaminants

Water Column Contaminants

Data collected under the California Surface Water Ambient Monitoring Program (SWAMP) for the period 2001−2005 indicate that at eight monitoring sites from the Oregon-California state line to Turwar, the majority of inorganic constituents (i.e., arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc) detected in the Hydroelectric Reach, Middle Klamath River, and Lower Klamath River were in compliance with water quality objectives. Aluminum concentrations ranged from 50.7 to 99.2 ug/L, so all samples were less than California primary drinking water standards[31] (1,000 ug/L), but some samples were slightly elevated above USEPA freshwater aquatic life standards (87 ug/L) along with USEPA and California secondary drinking water standards[32] (50 ug/L) (North Coast Regional Board 2008). Grab samples were analyzed for 100 pesticides, pesticide constituents, isomers, or metabolites; 50 polychlorinated biphenyl (PCB) congeners; and six phenolic compounds. Results indicated no PCBs and only occasional detections of pesticides (North Coast Regional Board 2008) (see Appendix C for more detail). The results of water quality studies during 2002 and 2003 at four USGS gage stations downstream of Iron Gate Dam

[31] Primary drinking water standards are limits for inorganic and organic contaminants to protect public health.
[32] Secondary drinking water standards are guidelines to prevent aesthetic effects (e.g., taste, odor, or color) or cosmetic effects (skin or tooth discoloration).

indicate that, with the exception of nickel, magnesium, and calcium, the concentration of trace elements decreased as water flowed downstream, most likely because of binding to other particles and settling out of the water column (Flint et al. 2005) (see Appendix C for more detail).

Sediment Contaminants

To investigate the potential for toxicity of sediments in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs, Shannon & Wilson, Inc. (2006) collected 25 sediment cores in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs and analyzed them for a suite of potential contaminants. The sediment cores were collected as part of a larger study sponsored by the California State Coastal Conservancy (GEC 2006). The locations of the sediment cores were distributed throughout each reservoir, including locations on the historical Klamath River channel (on-thalweg) and surrounding submerged terraces or near tributary mouths (off-thalweg) along the edge of the historical Klamath River. Four locations (4 on-thalweg, 0 off-thalweg) were sampled in J.C. Boyle Reservoir, with maximum core depths ranging from 0.3 feet at the upstream end of the reservoir to 13.2 feet near the dam. Twelve locations (7 on-thalweg, 5 off-thalweg) were sampled in Copco No. 1 Reservoir with maximum core depths ranging from 1.5 feet at the upstream end of the reservoir to 12.1 feet near the middle of the reservoir. Nine locations (5 on-thalweg, 4 off-thalweg) were sampled in Iron Gate Reservoir with maximum core depths ranging from 0.7 feet at the upstream end of the reservoir to 7.8 feet within the Slide Creek/Camp Creek arm of the reservoir. During sediment core drilling, the sediments were evaluated to distinguish recent reservoir-deposited sediment from pre-reservoir sediment, with drilling logs noting the depth of different sediment horizons. Shannon & Wilson, Inc. (2006) used a composite sampling[33] technique to represent field conditions for reservoir sediment deposits. Interval composite/depth interval sediment samples were generated from the sediment cores, including both the reservoir-deposited and pre-reservoir sediments, with the number of interval samples depending on the total depth of the sediment core. The sediment samples were analyzed for contaminants, including acid volatile sulfides, metals, pesticides, chlorinated acid herbicides, PCBs, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), cyanide, and dioxins. No herbicides or PCBs were found above U.S. Army Corps of Engineers (USACE) Puget Sound Dredged Disposal Analysis Program (PSDDA) screening levels and only one sample exceeded applicable PSDDA screening levels for VOCs ethyl benzenes and total xylenes (Shannon & Wilson, Inc. 2006). While cyanide was detected in multiple sediment cores, it was not found in the bioavailable toxic free cyanide form (HCN or CN^-).

Dioxin, a known carcinogen, was also measured in the Shannon & Wilson, Inc. (2006) study. Long-term exposure to dioxin in humans is linked to impairment of the immune system, the developing nervous system, the endocrine system, and reproductive functions. In the 2006 J.C. Boyle, Copco No. 1 and Iron Gate reservoir samples, measured levels were 2.48–4.83 pg/g (picograms per gram or parts per trillion [ppt] expressed as Toxic Equivalent Concentrations) and did not exceed USACE (1,000 pg/g), International Joint Commission for Great Lakes Science Advisory Board (10 pg/g), PSDDA (15 pg/g), or Washington State Department of Ecology (8.8 pg/g) (Shannon & Wilson, Inc. 2006, Dillon 2008, USEPA 2010) and the measured dioxin concentrations

[33] Composite samples are created by combining and thoroughly mixing individual samples from different locations and treating the combined sample as a single sample for analysis. Composite samples are a standard method for determining average conditions.

were within the estimated background dioxin concentrations (2–5 ppt) for non-source-impacted sediments throughout the U.S. and specifically in the western U.S. (USEPA 2010). However, the range of measured dioxin concentrations was slightly above the minimum for the U.S. Environmental Protection Agency fish and wildlife guidelines (2.5–210 pg/g) screening levels for human health and ecological receptors (Shannon & Wilson, Inc. 2006, Dillon 2008, USEPA 2010) (see Appendix C for more detail).

As part of the Klamath Dam Removal Secretarial Determination studies, a sediment evaluation was undertaken during 2009–2011 to evaluate potential environmental and human health impacts of the downstream release of sediment deposits currently stored behind the Lower Klamath Project dams[34]. Sediment cores were collected during 2009–2010 at 37[35] sites on the historical Klamath River channel (on-thalweg) and surrounding submerged terraces or near tributary mouths along the edge of the historical Klamath River (off-thalweg), distributed throughout J.C. Boyle Reservoir (Figure 2.6-4), Copco No. 1 Reservoir (Figure 2.6-5), Iron Gate Reservoir (Figure 2.6-6), and the Klamath River Estuary (Figure 3.2-6) (USBR 2010, 2011). Twelve sites (7 on-thalweg, 5 off-thalweg) were sampled in J.C. Boyle Reservoir with maximum core depths ranging from 0.3 feet near the middle of the reservoir to 18.7 feet near the dam. Twelve sites (7 on-thalweg, 5 off-thalweg) were sampled in Copco No. 1 Reservoir with maximum core depths ranging from 1.2 feet on an off-thalweg site downstream of the Beaver Creek arm of the reservoir to 9.7 feet on an off-thalweg location upstream of the Beaver Creek arm of the reservoir. Thirteen sites (8 on-thalweg, 5 off-thalweg) were sampled in Iron Gate Reservoir with maximum core depths ranging from 0.5 feet at the upstream end of the reservoir to 7.7 feet within the Jenny Creek arm of the reservoir. At each site, cores were inspected by on-site geologists to verify that the reservoir-deposited/pre-reservoir sediment contact had been reached for each core. Sediment cores were used to either create whole core composite[33] sediment samples or interval composite/depth interval composite sediment samples for laboratory analysis of potential contaminants with samples representing both the reservoir-deposited and pre-reservoir sediments. Area composite samples were also generated from sediment cores for the Klamath River Estuary. A total of 501 analytes were quantified in the sediment samples, including metals, poly-cyclic aromatic hydrocarbons (PAHs), PCBs, pesticides/herbicides, phthalates, VOCs, SVOCs, dioxins, furans, and polybrominated diphenyl ethers (PBDEs) (i.e., flame retardants). The chemical composition of sediment and elutriate[36] sediment samples were analyzed, and bioassays were conducted on the sediment and elutriate sediment samples using fish and invertebrate national benchmark toxicity species (see below for discussion of the bioaccumulation component of this study).

[34] There are currently 13.1 million cubic yards of sediment deposits stored within J.C. Boyle, Copco No. 1 and 2, and Iron Gate reservoirs (Table 2.7-7). Prior estimates of the sediment deposits were 14.5 million cubic yards (Eilers and Gubala 2003) and 20.4 million cubic yards (GEC 2006).

[35] Of the 37 sampling sites, two sites in J.C. Boyle, two in Copco No. 1, and three in Iron Gate Reservoir were analyzed for dioxins/furans, PCBs, and PBDEs.

[36] Elutriate sediment samples were created from reservoir composite sediment samples mixed with reservoir water (e.g., one part sediment to four parts water). In general, elutriate tests are a standard approach that analyzes the chemical composition of the overlying water of the elutriate sediment sample in order to estimate potential chemical concentrations in the water between the grains of sediment (pore water). Standard elutriate tests do not reflect the full dilution of re-suspended sediments that would occur during dam removal.

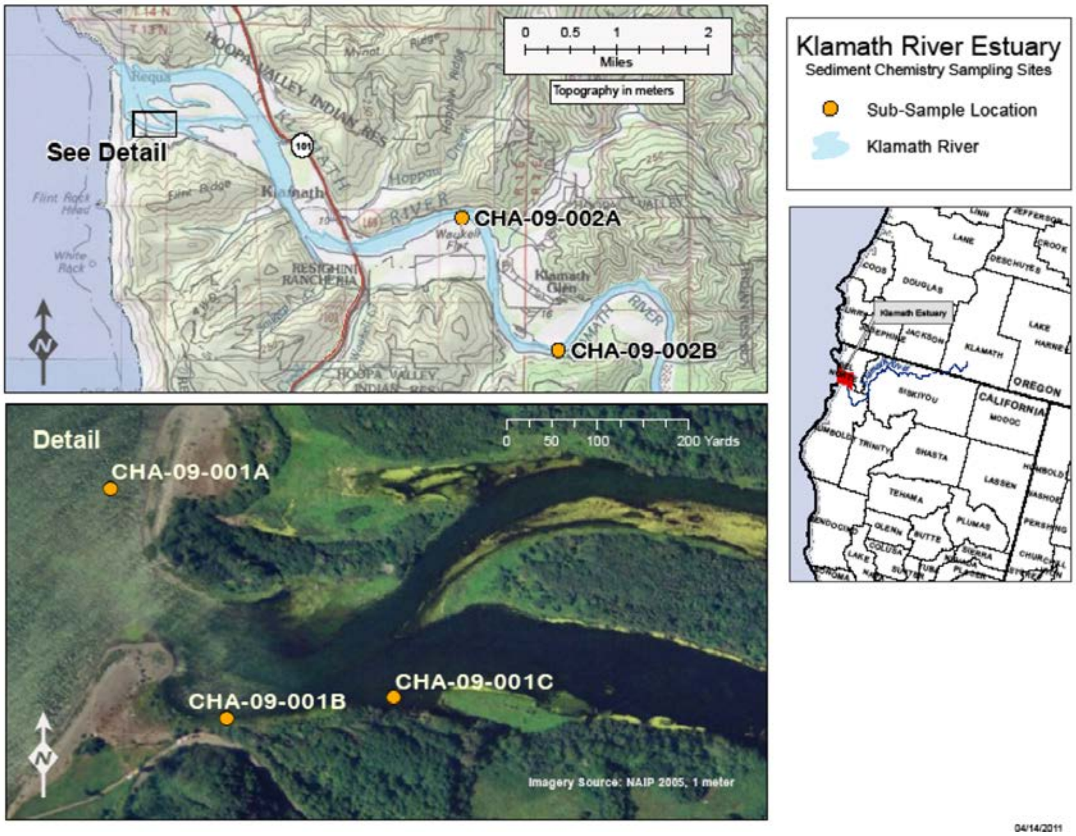

Figure 3.2-6. Klamath River Estuary Sediment Sampling Site Locations. Source: USBR 2011.

A relatively small number of chemicals of potential concern (COPCs) were identified in Lower Klamath Project reservoir sediment samples. Nickel, iron, and 2,3,4,7,8-pentachlordibenzofuran (PECDF) were detected in sediment in all three Lower Klamath Project reservoirs, while 4,4'-dichlorodiphenyltrichloroethane (DDT), 4,4'-dichlorodiphenyldichloroethane (DDD), 4,4'-dichlorodiphenyldichloroethylene (DDE), dieldrin, and 2,3,7,8-tetrachlorodibenzodioxin (TCDD) were detected only in J.C. Boyle sediments. No consistent pattern of elevated chemical composition was observed across discrete sampling locations within a reservoir, but sediment in J.C. Boyle Reservoir does have marginally higher iron concentrations and more detected COPCs in sediment when compared to Copco No. 1 and Iron Gate reservoirs and the Klamath River Estuary. Also, J.C. Boyle Reservoir exhibited more COPCs based on comparison to CalEPA, National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), USEPA, and ODEQ freshwater ecological and human health screening levels (SLs). However, in the case of J.C. Boyle Reservoir, and in other instances where elevated concentrations of chemicals in sediment were found, the degree of exceedance based on comparisons of measured detected chemical concentrations to SLs was small, and in several cases (i.e., arsenic, mercury, 2,3,7, 8-TCDD, total PCBs) may reflect regional background conditions (see Appendix C, Section C.7.1.1 for more detail). Toxicity tests generally indicated low potential for sediment toxicity to benchmark benthic indicator species; the exception to this occurred in a single sample from J.C. Boyle Reservoir, where survival of the benthic amphipod *Hyalella azteca* indicated a moderate potential for sediment toxicity.

Lastly, analysis of the 2009–2010 USBR collected sediment core results (USBR 2010, 2011) from J.C. Boyle, Copco No. 1, and Iron Gate reservoirs and the Klamath River Estuary indicate that total chromium and total nickel concentrations are higher in estuary sediments than in Lower Klamath Project reservoir sediments, but total arsenic, total copper, and total lead concentrations are higher in reservoir sediments than estuary sediments (Eagles-Smith and Johnson 2012). Total arsenic concentrations in the reservoir sediments samples range from 4.3 milligrams per kilogram, dry weight (mg/kg) to 15 mg/kg in J.C. Boyle Reservoir, 6.3 mg/kg to 13 mg/kg in Copco No. 1 Reservoir, and 7.4 mg/kg to 10 mg/kg in Iron Gate Reservoir, which exceed USEPA total carcinogen residential screening levels (0.39 mg/kg) and CalEPA California Human Health residential (0.07 mg/kg) and commercial (0.24 mg/kg) screening levels. Peak total copper concentrations in Lower Klamath Project reservoir sediments (9.8−38 mg/kg) are greater than total copper concentrations in Klamath River Estuary sediments (19−26 mg/kg) (Eagles-Smith and Johnson 2012). Total copper concentrations in Lower Klamath Project reservoir and Klamath River Estuary sediments only exceeded lower NOAA Screen Quick References Table (SQuiRT) freshwater and marine screening levels for copper in sediment (**freshwater**: Threshold Effect Concentrations [31.6 mg/kg], Threshold Effects Level [37.3 mg/kg], Lowest Effect Level [16 mg/kg]; **marine**: T20 [chemical concentration corresponding to 20 percent probability of observing toxicity] [32 mg/kg], Threshold Effects Level [18.7 mg/kg], Effects Range-Low [34 mg/kg]) with no measured total copper concentrations in reservoir or estuary sediments above freshwater or marine probable effects concentrations (freshwater: Probable Effect Concentrations [149 mg/kg], Probable Effect Level [197 mg/kg]; marine: T50 [chemical concentration corresponding to 50 percent probability of observing toxicity] [94 mg/kg], Probable Effect Level [108 mg/kg]). Total lead concentrations in reservoir sediments range from 2.8 mg/kg to 25 mg/kg in J.C. Boyle Reservoir, 6.4 mg/kg to 10 mg/kg in Copco No. 1 Reservoir, and 5.1 mg/kg to 11 mg/kg in Iron Gate Reservoir, which are consistently below USEPA total non-carcinogen residential screening levels (400 mg/kg) and CalEPA California Human Health residential (80 mg/kg) and commercial (320 mg/kg) screening levels (CDM 2011).

Note that while total metal concentrations were measured in the existing sediment cores, metals are typically bound to fine sediments and exhibit limited bioavailability or aquatic toxicity. The amount of bioavailable metals released by sediments may vary significantly depending on the sediment (surface area, availability of sorption sites, organic material, and clay content) and water properties (temperature, dissolved organic compounds, suspended particles, pH, various inorganic cations and anions like those composing hardness and alkalinity) (USEPA 2007).

Contaminants in Aquatic Biota

Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project−Algal Toxins* presents a discussion of algal toxins (i.e., microcystin) in fish tissue. Assessments of other contaminants in fish tissue for the Hydroelectric Reach have been undertaken by SWAMP and PacifiCorp. SWAMP data include sport fish tissue samples collected during 2007 and 2008 to evaluate accumulated contaminants in nearly 300 lakes throughout California. Sport fish were sampled to provide information on potential human exposure to selected contaminants and to represent the higher aquatic trophic levels (i.e., the top of the aquatic food web).

In a screening-level study of potential chemical contaminants in fish tissue in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs, PacifiCorp analyzed metals (i.e., arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc), organochlorine (pesticide) compounds, and PCBs in largemouth bass (*Micropterus salmoides*) and black bullhead catfish (*Ameiurus melas*) (PacifiCorp 2004c, FERC 2007). PacifiCorp reported that, in general, contaminant levels in fish tissue were below screening level values for protection of human health (USEPA 2000) and recommended guidance values for the protection of wildlife (MacDonald 1994). Exceptions to this include some tissue samples for total mercury, arsenic, total DDTs and total PCBs when compared to screening levels for wildlife and subsistence fishers (individual comparisons are shown in Appendix C for more detail). Dioxins were not tested.

Fish tissue samples also were collected in Copco No. 1 and Iron Gate reservoirs and analyzed for total mercury, selenium, and PCBs (Iron Gate Reservoir only) as part of a larger SWAMP study of contaminants in sport fish in California lakes and reservoirs (Davis et al. 2010). SWAMP data for Iron Gate and Copco No. 1 reservoirs indicate mercury tissue concentrations above the USEPA criterion of 300 nanograms per gram (ng/g) methylmercury (for consumers of noncommercial freshwater fish); and greater than OEHHA public health guideline levels advisory tissue levels (Klasing and Brodberg 2008) for consumption for 3 and 2 servings per week (70 and 150 ng/g wet weight, respectively) and the fish contaminant goal (220 ng/g wet weight). Measured selenium concentrations were 3–4 orders of magnitude lower than OEHHA thresholds of concern (2,500–15,000 ng/g wet weight) and PCB concentrations were below the lowest OEHHA threshold (i.e., fish contaminant goal of 3.6 ng/g wet weight) (Davis et al. 2010).

To supplement existing fish tissue data and provide additional lines of evidence in the Klamath Dam Removal Secretarial Determination sediment evaluation (see *Sediment Contaminants* above and Appendix C – *Section C.7.1.1*), two species of field-caught fish (perch and bullhead) were collected during late September 2010 from J.C. Boyle, Copco No. 1, and Iron Gate reservoirs and analyzed for contaminant levels in fish tissue (CDM 2011; see Appendix C – *Section C.7.1.1* for more detail). Results indicate that multiple chemicals were present in fish tissue (e.g., arsenic, DDE/DDT, dieldrin, mercury, mirex, selenium, and total PCBs; see Appendix C for a complete list of chemicals detected) (CDM 2011). Mercury exceeded tissue-based toxicity reference values for perch in Iron Gate Reservoir and bullhead samples in all three reservoirs (CDM 2011). Toxicity reference values are not available for several chemicals detected in invertebrate and fish tissue (CDM 2011, see Appendix C – *Section C.7.1.1* for more detail). Toxicity equivalent quotients (TEQs) for dioxin, furan, and dioxin-like PCBs in reservoir and estuary sediment samples were within the range of local background values and suggest a potential to cause minor or limited adverse effects for fish exposed to reservoir sediments (CDM 2011).

Lastly, Copco No. 1 and Iron Gate reservoirs are included on the 303(d) list of impaired waterbodies for mercury based on elevated methylmercury concentrations in fish tissue for trophic level 4 fish (USEPA 2001; PacifiCorp 2004b; Davis et al. 2010; CDM 2011; State Water Board 2017). A mercury TMDL for Copco No. 1 and Iron Gate reservoirs has not been completed.

3.2.3 Significance Criteria

Significance criteria used for the evaluation of impacts on water quality are listed below. Designated beneficial uses and associated water quality objectives for the Klamath River in California are defined in the Basin Plan (North Coast Regional Board 2018), the

Hoopa Valley Tribe Water Quality Control Plan (HVTEPA 2008), and the Yurok Tribe Water Quality Control Plan for the Yurok Indian Reservation[37] (YTEP 2004) (see Table 3.2-2).

Effects on water quality are considered significant if the Proposed Project would:

- Cause an exceedance of water quality standards as identified in the above documents in the areas addressed by the relevant plans;
- Substantially exacerbate an existing exceedance of water quality standards as identified in the above documents in the areas addressed by the relevant plans;
- Cause water quality changes that would result in a failure to maintain existing beneficial uses at the levels currently supported, or result in a failure to maintain high quality waters at the highest level of water quality consistent with the maximum benefit to the people of the State, meaning:
    - The action degrades high quality waters to an extent inconsistent with recent beneficial uses or in a manner that would result in water quality below that required by an applicable water quality control plan; or
    - The action involves a discharge that either does not comply with best practicable treatment or does not employ controls that avoid nuisance or pollution and are consistent with the maximum benefit to the people of the State.
- Result in substantial adverse impacts on human health or environmental receptors.

Unless otherwise indicated in Section 3.2.3.1 *Thresholds of Significance*, for purposes of determining the significance of any potential water quality impacts, "substantial," as used in the significance criteria, means the effect on water quality and the support of beneficial uses (or human health or environmental receptors, as specified) is of considerable importance.

For the Lower Klamath Project water quality analysis, short-term is defined as the period during pre-dam removal activities, reservoir drawdown, dam removal, and associated sediment flushing events, which corresponds to pre-dam removal activities that would occur in the one to three years before dam removal, dam removal year 1, dam removal year 2, and post-dam removal year 1 (Table 2.7-1). Long-term is defined as occurring after post-dam removal year 1 (i.e., greater than three years after dam removal).

Significance criteria related to groundwater and flood hydrology (i.e., subsurface drainage, flooding, inundation) are addressed in Section 3.6 *Flood Hydrology* and/or Section 3.7 *Groundwater*.

[37] USEPA approval for treatment of the Yurok Tribe as a State for purposes of operating a water quality standard program has not yet occurred (CWA §§ 303(c)/401).

Table 3.2-2. Designated Beneficial Uses of Water in the Water Quality Area of Analysis.

North Coast Regional Board (Basin Plan 2018)[1,2]	Hoopa Valley Tribe (HVTEPA 2008)[3]	Yurok Tribe (YTEP 2004)[3]
Aesthetics, Cultural, and Subsistence		
N/A	Wild and Scenic (W&S)	N/A
Native American Culture (CUL)	Ceremonial and Cultural Water Use (CUL)**	Cultural (CUL)
Subsistence Fishing (FISH)	N/A	N/A
Agricultural Water Supply		
Agricultural Supply (AGR)	Agricultural Supply (AGR)*	Agricultural Supply (AGR)
Commercial		
Commercial and Sport Fishing (COMM)	N/A	Commercial and Sport Fishing (COMM)
Shellfish Harvesting (SHELL)	N/A	N/A
Mariculture[4]/Aquaculture (AQUA)	N/A	N/A
Fish & Wildlife		
Warm Freshwater Habitat (WARM)	N/A	Warm Freshwater Habitat (WARM)
Cold Freshwater Habitat (COLD)	Cold Freshwater Habitat (COLD)	Cold Freshwater Habitat (COL)
Migration of Aquatic Organisms (MIGR)	Migration of Aquatic Organisms (MIGR)	Migration of Aquatic Organisms (MGR)
Spawning, Reproduction, and/or Early Development (SPWN)	Spawning, Reproduction, and/or Early Development (SPWN)	Spawning, Reproduction, and/or Early Development (SPN)
Estuarine Habitat (EST)	N/A	Estuarine Habitat (EST)
Marine Habitat (MAR)	N/A	Marine Habitat (MAR)
Wildlife Habitat (WILD)	Wildlife Habitat and Endangered Species (WILD)	Wildlife Habitat (WLD)
Preservation and Enhancement of Designated Areas of Special Biological Significance (ASBS) [4]	N/A	Preservation of Areas of Special Biological Significance (BIO)
Rare, Threatened, or Endangered Species (RARE)	Preservation of Threatened and Endangered Species (T&E)	Rare, Threatened, or Endangered Species (RARE)
Saline Habitat (SAL)	N/A	N/A

North Coast Regional Board (Basin Plan 2018)[1,2]	Hoopa Valley Tribe (HVTEPA 2008)[3]	Yurok Tribe (YTEP 2004)[3]
Potable Water Supply		
Municipal and Domestic Supply (MUN)	Municipal and Domestic Supply (MUN)*	Municipal and Domestic Supply (MUN)
Industrial Water Supply		
Industrial Service Supply (IND)	Industrial Service Supply (IND)	N/A
Industrial Process Supply (PROC)	Industrial Process Supply (PROC)	
Hydropower Generation (POW)	N/A	Hydropower Generation (PWR)
Navigation		
Navigation (NAV)	N/A	Navigation (NAV)
Replacement/Recharge		
Groundwater Recharge (GWR)	Groundwater Recharge (GWR)	Groundwater Recharge (GW)
Freshwater Replenishment (FRSH)	N/A	Freshwater Replenishment (FRSH)
Recreation		
Water Contact Recreation (REC-1), including Aesthetic Enjoyment[4]	Water Contact Recreation (REC-1)	Water Contact Recreation (REC-1)
Non-contact Water Recreation (REC-2), including Aesthetic Enjoyment[4]	Non-contact Water Recreation (REC-2)	Non-contact Water Recreation (REC-2)

Notes:
[1] Beneficial Uses listed (existing and potential) apply to one or more Basin Plan specified hydrologic areas, sub-areas, or waterbodies within the Water Quality Area of Analysis, but they do not necessary apply all reaches within the Water Quality Area of Analysis.
[2] Basin Plan designated Beneficial Uses apply to the entire Water Quality Area of Analysis, including the territorial marine waters of the State of California.
[3] Tribal designated Beneficial Uses apply to the sections of the Water Quality Area of Analysis within the tribal boundaries.
[4] These Beneficial Uses come from the Basin Plan's incorporation of the State Water Board's 2015 Ocean Plan, which applies to the territorial marine waters of the State of California.
Key:
N/A: Not applicable
* = Proposed Beneficial Use
** = Historical Beneficial Use

Table 3.2-3. Water Bodies Included on the 303(d) List within the Water Quality Area of Analysis.[1]

Water Body/Reach	Water Temperature	Sediment	Organic Enrichment/Low Dissolved Oxygen	Nutrients	Microcystin	Mercury	Aluminum
Hydroelectric Reach of the Upper Klamath River – Oregon-California state line to the upstream end of Copco No. 1 Reservoir	X		X	X			
Hydroelectric Reach of the Upper Klamath River – upstream end of Copco No. 1 Reservoir to Iron Gate Dam (excluding Copco No.1 and No. 2 and Iron Gate Reservoir)	X		X	X	X		
Copco No. 1 Reservoir	X				X	X	
Copco No. 2 Reservoir	X				X		
Iron Gate Reservoir	X				X	X	
Middle Klamath River – Iron Gate Dam to Scott River	X	X	X	X	X		X
Middle and Lower Klamath River – Scott River to Trinity River	X	X	X	X	X		
Lower Klamath River – Trinity River to Mouth	X	X	X	X			

1 While there are additional water quality impaired waterbodies in the Klamath Basin, the waterbodies listed in this table are the ones that are directly relevant to the water quality analysis for the Proposed Project.

3.2.3.1 Thresholds of Significance

Thresholds of significance for this EIR are identified for water temperature, suspended sediment, nutrients, dissolved oxygen, pH, chlorophyll-*a* and algal toxins, and inorganic and organic contaminants. All of these are a water quality concern due to their potential to influence multiple designated beneficial uses and because hydroelectric project operations can affect these constituents (see Section 3.2.2.1 *Overview of Water Quality Processes in the Klamath Basin*). Table 3.2-4 through Table 3.2-10 provide the existing water quality objectives for: (1) the Basin Plan (North Coast Regional Board 2018), which incorporates the provisions of the Water Quality Control Plan for Ocean Waters of California (Ocean Plan) and the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan); (2) the Hoopa Valley Tribe Water Quality Control Plan (HVTEPA 2008); and (3) the Yurok Tribe Water Quality Control Plan for the Yurok Indian Reservation[37] (YTEP 2004). The water quality objectives are interpreted in this water quality analysis to determine the applicable thresholds of significance for this EIR since there are multiple overlapping water quality objectives, quantitative objectives are not available for some water quality parameters when objectives are narrative, and there is a lack of background information available to apply objectives that are relative background conditions. Applicable numeric values used as thresholds of significance for the Lower Klamath Project analysis include water temperature, dissolved oxygen, and pH. There are multiple numeric standards for algal toxins potentially applicable for the Klamath River, so these various numeric standards are evaluated in the sub-section titled *Chlorophyll-a and Algal Toxins* (after Table 3.2-4, Table 3.2-9, and Table 3.2-10) to identify the appropriate threshold of significance for algal toxins in this EIR. Numeric and narrative water quality objectives for various inorganic and organic contaminant were combined into a broad set of thresholds of significance as described below in the sub-section titled *Inorganic and Organic* (after Table 3.2-4, Table 3.2-9, and Table 3.2-10).

Other numeric values presented in Table 3.2-4 through Table 3.2-10, including California turbidity standards, California nitrate and nitrite standards for the support of municipal beneficial uses, the Hoopa Valley Tribe criterion for chlorophyll-*a* as periphyton, and the Hoopa Valley Tribe and Yurok Tribe ammonia and nitrate standards for the support of cold freshwater habitat and municipal beneficial uses, are not used as thresholds of significance. The California surface water quality objective for turbidity could not be used as a threshold of significance for suspended sediment since it is based on a comparison to naturally occurring background levels, but there is not readily available data on turbidity in the Klamath River. The threshold of significance for suspended sediment in this EIR is discussed below in the sub-section titled *Suspended Sediments* (after Table 3.2-4, Table 3.2-9, and Table 3.2-10).

The California surface water quality objectives for nitrate (NO_3) and nitrate and nitrite (NO_3 + NO_2), along with the Hoopa Valley Tribe and Yurok Tribe nitrate water quality objective, are not appropriate thresholds of significance for nutrients in this EIR since they are based on supporting municipal beneficial uses (i.e., drinking water). These objectives are much higher than concentrations that have been measured in the Klamath Basin, such that there is no indication that the municipal beneficial use is not being met or would not be met in the future under the Proposed Project. Thus, other water quality objectives are evaluated to determine the threshold of significance for nutrients in this EIR, as discussed below in the sub-section titled *Nutrients* (after Table 3.2-4, Table 3.2-9, and Table 3.2-10).

The Hoopa Valley Tribe criterion for chlorophyll-*a* as periphyton is not an appropriate threshold of significance for chlorophyll-*a* since it is based on periphyton growth rather than phytoplankton growth; periphyton growth is assessed in detail in Section 3.4 *Phytoplankton and Periphyton*, and it is only applicable to a short reach (at approximately RM 45) of the Klamath River upstream of the Trinity River. Thus, criteria are evaluated to determine the threshold of significance for chlorophyll-a in this EIR, as discussed below in the sub-section titled *Chlorophyll-a and Algal Toxins* (after Table 3.2-4, Table 3.2-9, and Table 3.2-10).

The Hoopa Valley Tribe and Yurok Tribe have an ammonia toxicity objective based on pH and temperature (Table 3.2-7 and Table 3.2-8, respectively), but these objectives are not used as a threshold of significance for toxicity since available data suggests there are no actual ammonia toxicity events associated with the operation of the Lower Klamath Project (North Coast Regional Board 2010). Similarly, the Yurok Tribe has a nitrite water quality objective (Table 3.2-8), but available data does not suggest operation of the Lower Klamath Project influences nitrite concentrations in the Klamath River. Turbulent mixing and dissolved oxygen conditions in the Klamath River under the Proposed Project would promote the conversion of ammonia to nitrate or nitrite to nitrate and minimize the potential for ammonia or nitrite toxicity. The potential for short-term toxicity to aquatic organisms during reservoir drawdown, including consideration of ammonia toxicity, is addressed using bioassay results (see Section 3.2.4.7 *Inorganic and Organic Contaminants*).

Table 3.2-4. California Surface-Water Quality Objectives Relevant to the Proposed Project.

Parameter	Description[1]
Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.
Sediment	The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Turbidity	Turbidity shall not be increased more than 20% above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.
Temperature	Intrastate waters (Basin Plan) • No alteration of natural receiving water temperature of intrastate waters that adversely affects beneficial uses. • At no time or place shall the temperature of any **COLD** water be increased by more than 5°F above natural receiving water temperature. • At no time or place shall the temperature of **WARM** intrastate waters be increased more than 5°F above natural receiving water temperature. Interstate waters (Thermal Plan) • Elevated temperature waste discharges into **COLD** interstate waters are prohibited. • Thermal waste discharges having a maximum temperature greater than 2.8ºC (5ºF) above natural receiving water temperature are prohibited for **WARM** interstate waters. • Elevated temperature wastes shall not cause the temperature of **WARM** interstate waters to increase by more than 5°F above natural temperature at any time or place.
Dissolved Oxygen	**WARM, MAR, Inland Saline Water Habitat (SAL), COLD, SPWN** Klamath River Mainstem Specific Water Quality Objectives based on natural receiving water temperatures (see Table 3.1a for minimum dissolved oxygen concentrations in mg/L) • From Oregon-California state line (RM 214.1) to the Scott River (RM 145.1), 90% saturation October 1-March 31 and 85% saturation April 1-September 30. • From Scott River (RM 145.1) to Hoopa Valley Tribe boundary (≈RM 45), 90% saturation year-round. • From Hoopa Valley Tribe boundary to Turwar (RM 5.6), 85% saturation June 1-August 31 and 90% saturation September 1-May 31. • For upper and middle Klamath River Estuary (RM 0-3.9), 80% saturation August 1-August 31, 85% saturation September 1-October 31 and June 1-July 31, and 90% saturation November 1-May 31. • **EST** for Lower Klamath River Estuary (RM 0), dissolved oxygen content shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.

Parameter	Description[1]
Biostimulatory Substances	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.
Nitrate	**MUN** 45 mg/L as NO_3 (equivalent to 10 mg/L for nitrate as N)[2]
Nitrate + Nitrite	**MUN** 10 mg/L as N [3]
pH	The pH shall not be depressed below 6.5 units nor raised above 8.5 units, unless otherwise state below
	COLD, WARM Changes in normal ambient pH levels in fresh waters shall not exceed 0.5 units within the range specified above. **MAR, SAL** Changes in normal ambient pH levels shall not exceed 0.2 units
	The pH shall not be depressed below 7 units nor raised above 8.5 units for the Klamath River upstream of Iron Gate Dam, including Iron Gate and Copco No.1 reservoirs, the Klamath River in the Middle Klamath River Hydrologic Area downstream from Iron Gate Dam, and the Klamath River in the Lower Klamath River Hydrologic Area.
Toxicity	All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.
Pesticides	No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no bioaccumulation of pesticide concentrations found in bottom sediments or aquatic life. Waters designated for use as domestic or municipal supply shall not contain concentrations of pesticides in excess of the limiting concentrations set forth in California Code of Regulations, title 22, section 64444 (Table 64444-A), and listed in Table 3-1 of the Basin Plan.
Chemical Constituents	Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the limits specified in California Code of Regulations, title 22, section 64431 (Table 64431-A) and section 64444 (Table 64444-A) and listed in Table 3-1 of the Basin Plan. Waters designated for use as agricultural supply (AGR) shall not contain concentrations of chemical constituents in amounts which adversely affect such beneficial use.

Source: North Coast Regional Board (2018) unless otherwise noted.

[1] Relevant beneficial uses are shown in bold and all caps. If no beneficial use is specified, the objective or criteria applies to all beneficial uses.

[2] Maximum contaminant level for domestic or municipal supply.

[3] Maximum contaminant level (shall not be exceeded in water supplied to the public) as specified in Table 64431-A (Inorganic Chemicals) of Section 64431, Title 22 of the California Code of Regulations, as of December 20, 2018.

Table 3.2-5. Minimum Dissolved Oxygen Concentrations in mg/L Based on Percent Saturation Criteria (North Coast Regional Board 2010).

Dissolved Oxygen Concentrations (mg/L)	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Stateline to Scott River – 90% October 1 through March 31 and 85% April 1 through September 30												
Stateline	10.4	9.6	8.5	7.6	7.0	6.3	6.3	6.4	6.9	7.8	9.5	10.6
Downstream Copco Dam	10.4	9.6	8.5	7.6	6.9	6.3	6.3	6.4	6.9	7.8	9.5	10.6
Downstream Iron Gate Dam	10.8	9.9	8.8	7.8	7.1	6.5	6.5	6.5	7.1	8.1	9.7	10.9
Upstream Shasta River	10.8	10.0	8.9	7.9	7.1	6.6	6.4	6.4	7.1	7.9	9.6	10.8
Downstream Shasta River	10.8	10.1	9.0	7.9	7.2	6.7	6.5	6.5	7.2	8.0	9.7	10.9
Upstream Scott River	10.9	10.2	9.1	8.1	7.2	6.7	6.4	6.5	7.1	7.9	9.8	10.9
Scott River to Hoopa – 90% all year												
Downstream Scott River	10.8	10.2	9.3	8.7	7.9	7.3	6.9	6.9	7.6	8.0	9.8	10.9
Seiad Valley	10.9	10.2	9.3	8.8	7.8	7.2	6.9	6.9	7.5	7.9	9.9	10.9
Upstream Indian Creek	11.0	10.3	9.4	8.9	8.0	7.3	7.0	7.0	7.5	7.9	9.9	10.8
Downstream Indian Creek	11.0	10.3	9.5	9.0	8.1	7.4	7.0	7.0	7.6	8.0	9.9	10.8
Upstream Salmon River	11.2	10.6	9.8	9.3	8.4	7.5	7.2	7.2	7.7	8.2	10.0	11.0
Downstream Salmon River	11.1	10.6	9.9	9.4	8.5	7.6	7.2	7.2	7.7	8.2	10.0	10.9
Hoopa to Turwar – 90% September 1 through May 31 and 85% June 1 through August 31												
Hoopa	11.0	10.6	10.0	9.5	8.5	7.2	7.0	6.9	7.8	8.3	10.1	11.0
Upstream Trinity River	11.0	10.6	10.0	9.5	8.5	7.2	7.0	6.9	7.8	8.3	10.0	11.0
Downstream Trinity River	10.9	10.6	9.9	9.5	8.6	7.4	7.1	7.0	7.9	8.4	10.0	10.9
Youngsbar	10.9	10.6	9.9	9.5	8.7	7.4	7.1	7.0	7.9	8.4	10.0	10.9
Turwar	10.9	10.5	9.9	9.5	8.6	7.2	6.9	6.8	7.6	8.1	9.8	10.8
Upper and Middle Estuary – 90% November 1 through May 31, 85% September 1 through October 31 and June 1 through July 31, 80% August 1 through August 31												
Upper Estuary	10.9	10.6	10.1	9.5	8.6	7.3	7.1	6.7	7.6	8.0	10.0	10.7
Middle Estuary	10.9	10.6	10.1	9.6	8.6	7.3	7.2	6.8	7.8	8.2	10.1	10.8
Lower Estuary – Narrative Objective												

Table 3.2-6. California Marine Water Quality Objectives Relevant to the Proposed Project.

Water Quality Objective[1]	Description
Physical Characteristics	• Floating particulates and grease and oil shall not be visible. • The discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface. • Natural light shall not be significantly reduced at any point outside the initial dilution zone as the result of the discharge of waste. • The rate of deposition of inert solids and the characteristics of inert solids in ocean sediments shall not be changed such that benthic communities are degraded.
Chemical Characteristics	• The dissolved oxygen concentration shall not at any time be depressed more than 10% from that which occurs naturally, as the result of the discharge of oxygen demanding waste materials. • The pH shall not be changed at any time more than 0.2 units from that which occurs naturally. • The dissolved sulfide concentration of waters in and near sediments shall not be significantly increased above that present under natural conditions. • The concentration of substances set forth in Chapter II, Table 1 (State Water Board 2015), in marine sediments shall not be increased to levels which would degrade indigenous biota. • The concentration of organic materials in marine sediments shall not be increased to levels that would degrade marine life. • Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota. • Numerical Water Quality Objectives for discharges are listed in Chapter II, Table 1 (State Water Board 2015), including objectives for the protection of marine aquatic life (i.e., metals, inorganics, organics, chronic and acute toxicity, pesticides and PCBs, radioactivity) and objectives for the protection of human health (noncarcinogenic and carcinogenic compounds).

Source: State Water Board (2015) unless otherwise noted.

[1] Water quality objectives for bacterial characteristics, radioactivity, and elevated temperature (thermal) wastes are not included, as these water quality parameters are not anticipated to be affected by the Proposed Project.

Table 3.2-7. Hoopa Valley Tribe Surface-Water Quality Objectives.

Parameter	Criteria/Description[1]
Ammonia (NH3, as mg/L N)	**COLD** Because ammonia toxicity to fish is influenced by pH, waters designated for the purpose of protection of threatened and endangered fish species in cold freshwater habitat shall meet conditions for ammonia based on maximum one-hour (acute) and 30-day average (chronic) concentrations linked to pH by the following formulas (HVTEPA 2008): Specific use numerical criteria: The one-hour average concentration of total ammonia nitrogen (in [milligrams nitrogen per liter] mg N/L) shall not exceed, more than once every three years on average, the CMC (acute criterion) calculated using the following equation. Where salmonid fish are present: $CMC = \frac{0.275}{1 + 10^{7.204-pH}} + \frac{39.0}{1 + 10^{pH-7.204}}$ The thirty-day average concentration of total ammonia nitrogen (in mg N/L) should not exceed, more than once every three years on average, the CCC (chronic criterion) calculated using the following equation. When fish early life stages are present: $CCC = \left(\frac{0.0577}{1 + 10^{7.688-pH}} + \frac{2.487}{1 + 10^{pH-7.688}}\right) x\ MIN\left(2.85, 1.45\ x\ 10^{0.028\ x\ (25-T)}\right)$ where T is the water temperature in Celsius.
Periphyton	150 mg chlorophyll-*a* /m^2
Dissolved oxygen[2]	**COLD** 8.0 mg/L minimum
	SPWN 11.0 mg/L minimum
	SPWN 8.0 mg/L minimum in inter-gravel water
Total Nitrogen (TN)[3,4]	0.2 mg/L
Total Phosphorous (TP)	0.035 mg/L
pH	The pH in the Klamath River shall be between 7.0 and 8.5 at all times
Microcystis aeruginosa cell density	**MUN, REC-1** Less than 5,000 cells/mL for drinking water Less than 40,000 cells/mL for recreational water
Microcystin toxin Concentration	**MUN, REC-1** Less than 1 ug/L total microcystins[5] for drinking water Less than 8 ug/L total microcystins[5] for recreational water
Total potentially toxigenic cyanobacteria [blue-green algae] species [6]	**MUN, REC-1** Less than 100,000 cells/mL for recreational water

Parameter	Criteria/Description[1]
Cyanobacterial [blue-green algae] scums	**MUN, REC-1** There shall be no presence of cyanobacterial [blue-green algae] scums
Nitrate	**MUN** 10 mg/L

Source: HVTEPA (2008)

[1] Relevant beneficial uses are shown in bold and all caps. If no beneficial use is specified, the objective or criteria applies to all beneficial uses.

[2] HVTEPA (2008) includes a natural conditions clause which states, "If dissolved oxygen standards are not achievable due to natural conditions, then the COLD and SPAWN standard shall instead be dissolved oxygen concentrations equivalent to 90% saturation under natural receiving water temperatures." USEPA has approved the Hoopa Valley Tribe definition of natural conditions; the provision that site-specific criteria can be set equal to natural conditions and the procedure for defining natural conditions have not been finalized as of December 2018.

[3] HVTEPA (2008) includes a natural conditions clause which states, "If total nitrogen and total phosphorus standards are not achievable due to natural conditions, then the standards shall instead be the natural conditions for total nitrogen and total phosphorus." USEPA has approved the Hoopa definition of natural conditions; the provision that site-specific criteria can be set equal to natural conditions and the procedure for defining natural conditions have not been finalized as of December 2018.

[4] 30-day mean of at least two sample per 30-day period.

[5] Total microcystins, as defined in the Hoopa Valley Tribe Surface-Water Objectives, is assumed to be equivalent to total microcystin for this EIR.

[6] Includes: *Anabaena*, *Microcystis*, *Planktothrix*, *Nostoc*, *Coelosphaerium*, *Anabaenopsis*, *Aphanizomenon*, *Gloeotrichia*, and *Oscillatoria*.

Table 3.2-8. Yurok Tribe Surface-Water Quality Objectives Relevant to the Proposed Project.

Parameter[1]	Description
Ammonia	Levels of ammonia shall not be increased, in any body of water, by human related activity that could cause a nuisance or adversely affect the water to support specified beneficial uses. Specific use[2] numerical criteria[3]: The one-hour average concentration of total ammonia nitrogen (in [milligrams nitrogen per liter] mg N/L) shall not exceed, more than once every three years on average, the CMC[4] (acute criterion) calculated using the following equation. Where salmonid fish are present: $$CMC = \frac{0.275}{1+10^{7.204-pH}} + \frac{39.0}{1+10^{pH-7.204}}$$ The thirty-day average concentration of total ammonia nitrogen (in mg N/L) should not exceed, more than once every three years on average, the CCC[5] (chronic criterion) calculated using the following equation. When fish early life stages are present: $$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}}\right) x\ MIN\left(2.85, 1.45\ x\ 10^{0.028\ x\ (25-T)}\right)$$ where T is the water temperature in Celsius. In addition, the highest four-day average within the 30-day period should not exceed 2.5 times the CCC.

Parameter[1]	Description
Biostimulatory Substances	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths could cause a nuisance or adversely affect the water to support specified beneficial uses.
Dioxins	No dioxin compounds will be discharged to any water within the YIR[6] boundaries.
Dissolved Oxygen	Dissolved oxygen concentrations shall not be altered by human caused activities that could cause a barrier to salmonid fish migration or adversely affect the water to support specified beneficial uses. Specific use[1] numerical criteria[3]: **Year-round objective in the water column** 7-day moving average of the daily minimum concentrations ≥ 8 mg/L **Intergravel objective during the incubation and emergence life stage** 7-day moving average of the daily minimum concentrations ≥ 8 mg/L **Water column objective during the incubation and emergence life stage** 7-day moving average of the daily minimum concentrations ≥ 11 mg/L.
Oil and Grease	Waters shall not contain oils, greases, waxes or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water that could cause a nuisance, or adversely affect the water to support specified beneficial uses.
Nitrate	Levels of nitrates in waters with municipal or domestic supply use shall not exceed 10 mg/L. In other bodies of water, the levels of nitrate shall not be increased by human related activity that could cause a nuisance, or adversely affect the water to support specified beneficial uses.
Nitrite	Levels of nitrites shall not be increased, in any body of water, by human related activity that could cause a nuisance, or adversely affect the water to support specified beneficial uses.
Pentachlorophenol (PCP)	No discharge of Pentachlorophenol will be allowed to any water body within the boundaries of the YIR. Any existing point or non-point source resulting in the presence of PCP shall be addressed as a non–compliance condition under the antidegradation plan.
Petroleum Hydrocarbons	No increase above background levels of petroleum hydrocarbons will be allowed due to human related activity in any water body within the YIR boundaries. Background levels shall be considered to be non-detect if baseline levels have not been established.
Pesticides	Pesticide concentrations, individually or collectively, shall not be detected by using the most recent detection procedures available. There shall be no detectable amount of pesticide concentrations found in bottom sediments. There shall be no detectable increase in bioaccumulation of pesticides in aquatic life.

Parameter[1]	Description
pH	Changes related to human caused activities in normal pH levels shall not exceed 0.5 pH units [s.u.]. pH levels shall not be below 6.5 [s.u.] and not exceed 8.5 [s.u.] due to human caused activities.[2]
Phosphates	Levels of phosphorous in any water body shall not be increased by human related activity above the levels that could cause a nuisance, or adversely affect the water to support specified beneficial uses.
Sediment	The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause a nuisance, or adversely affect the water to support specified beneficial uses. In addition, the placing or disposal of soil and silt from any operation where such material could cause a nuisance or adversely affect the water to support specified beneficial uses is prohibited.
Settleable Materials	Waters shall not contain substances caused by human activities in concentrations that result in deposition of material that could cause a nuisance, or adversely affect the water to support specified beneficial uses.
Suspended Materials	Waters shall not contain suspended materials caused by human activities in concentrations that could cause a nuisance, or adversely affect the water to support specified beneficial uses.
Temperature	The natural receiving water temperature shall not be altered unless it is shown to the YTEP[7], and the YTEP concurs, that it does not affect beneficial uses. See Table 3.2-9 for water temperature specific use[2] numerical criteria[3].
Toxicity	All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analysis of species diversity, population density, growth anomalies, bioassays of appropriate duration and/or other appropriate methods as specified by USEPA's toxicity test guidance.
Turbidity	Waters shall be free of human caused changes in turbidity that could cause a nuisance, or adversely affect the water to support specified beneficial uses. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof. Turbidity shall not exceed 5 Nephelometric Turbidity Units (NTU) over background turbidity when the background turbidity is 50 NTU or less or have more than a 10 percent increase in turbidity when the background is greater than 50 NTU.[8]

Parameter[1]	Description
Other Chemical Constituents	Waters used for domestic or municipal supply shall not contain concentrations of chemical constituents in amounts which adversely affect such beneficial use.

Source: YTEP (2004) unless otherwise noted.

[1] Water quality objectives for bacteria, boron, floating materials, hardness, radioactivity, and elevated temperature (thermal) wastes are not included, as these water quality parameters are not anticipated to be affected by the Proposed Project. Analysis of potential impacts to riverbed substrate composition is discussed in Section 3.11 Geology, Soils, and Mineral Resources. Analysis of potential impacts to the ability of tribes to use water for ceremonial and other purposes is discussed in Section 3.12 Historical Resources and Tribal Cultural Resources. Analysis of potential impacts to color is discussed in Section 3.19 Aesthetics. Consideration of hydrology under the Proposed Project is discussed in Section 3.1.6 Summary of Available Hydrology Information for the Proposed Project. Specific hydrologic conditions for the alternatives are discussed in Section 4 Alternatives.

[2] Waters listed with the designated uses of preservation of biological habitat with special significance (BIO), cold freshwater habitat (COL), commercial and sport fishing (COM), cultural and ceremonial activities (CUL), migration of aquatic organisms (MGR), municipal and domestic supply (MUN), navigation (NAV), contact recreation (REC-1), rare, threatened, or endangered species habitat (RARE), spawning, reproduction, and development habitat (SPN) shall meet the criteria over the entire length of the stream including connecting tributaries and the Pacific Ocean where applicable within Yurok Tribal jurisdiction.

[3] Specific use numerical criteria for ammonia adopted from USEPA's 1999 update of ambient water quality criteria for ammonia (USEPA 1999) and Hoopa Valley Tribe's 2001 WQCP (HVTEPA 2008).

[4] CMC = Criteria Maximum Concentrations

[5] CCC = Criterion Continuous Concentration

[6] YIR = Yurok Indian Reservation.

[7] YTEP = Yurok Tribe Environmental Program

[8] Turbidity levels adopted from the State of Washington as specified in Bash et al. (2001).

Table 3.2-9. Yurok Tribe Water Temperature Numerical Criteria.[1]

Life Stage	Time Period (Estimated)	MWAT[2] (°C/°F)	MWMT[3] (°C/°F)	Inst. Max (°C/°F)
Adult Migration	Year-round	15/59	17/62.6	21/69.8
Adult Holding	May–Dec.	14/57.2	16/60.8	22/71.6
Spawning	Sept.–Apr.	11/51.8	13/55.4	22/71.6
Incubation/Emergence All Salmonids except Coho	Jan.–May	11/51.8	13/55.4	22/71.6
Incubation/Emergence Coho Salmon	Nov.–Jun.	10/50	12/53.6	22/71.6
Juvenile Rearing	Year-round	15/59	17/62.6	22/71.6
Smoltification	Jan.–Jun.	12/53.6	14/57.2	22/71.6

Source: YTEP (2004)

[1] Waters listed with the designated uses of preservation of biological habitat with special significance (BIO), cold freshwater habitat (COL), commercial and sport fishing (COM), cultural and ceremonial activities (CUL), migration of aquatic organisms (MGR), municipal and domestic supply (MUN), navigation (NAV), contact recreation (REC-1), rare, threatened, or endangered species habitat (RARE), spawning, reproduction, and development habitat (SPN) shall meet the criteria over the entire length of the stream including connecting tributaries and the Pacific Ocean where applicable within Yurok Tribal jurisdiction.

[2] Mean Weekly Average Temperature

[3] Mean Weekly Maximum Temperature

Suspended Sediments

California has established separate water quality objectives for the two closely-related water quality parameters: suspended sediment (the amount of silt, clay, and other small particles in the water column) and turbidity (the clarity or murkiness of the water causes by small particles). California objectives for turbidity are based on comparing the clarity of the water currently to the clarity of the water under natural conditions (Table 3.2-4). However, there are not readily-available data on what turbidity levels are in the Klamath River under natural conditions, so increases in turbidity above natural conditions cannot be calculated for the Proposed Project in the manner anticipated by the Basin Plan (i.e. relative to natural conditions). While measurements of suspended sediments and turbidity are related such that a relationship can be determined to estimate turbidity from suspended sediments, or vice versa, the relationship between suspended sediments and turbidity varies between watersheds due to changes in sediment properties. Both suspended sediment and turbidity data must be collected at one or more locations in a river over a sufficiently long time period to characterize the range of suspended sediment and turbidity conditions and determine the relationship between the two parameters in the river near those locations; there currently is not sufficient data to develop this relationship in the Klamath River, either for natural conditions or for existing background conditions (Stillwater Sciences 2009). Thus, it is not possible to use the turbidity water quality objective directly, and accordingly the CEQA water quality impacts analysis uses the narrative sediment water quality objectives, rather than the numeric turbidity standards.

Basin Plan water quality objectives for suspended material, settleable material, and sediment are narrative and require that waters not contain concentrations that cause nuisance or adversely affect beneficial uses (Table 3.2-4). While the Klamath River has multiple designated beneficial uses, the use most sensitive to water quality is the cold freshwater habitat (COLD) associated with salmonids (North Coast Regional Board 2011). In order to adequately analyze short-term and long-term impacts[38] of the Proposed Project on this beneficial use, the water quality impact analysis assesses the narrative suspended material water quality objective using the predicted suspended sediment concentrations (SSCs)[39] for two to 50 years beginning with the initiation of drawdown in the Lower Klamath Project reservoirs. Predictions of SSCs during dam removal were determined as part of the extensive sediment transport modeling conducted for the Klamath Dam Removal Secretarial Determination process (USBR 2012). The narrative suspended material water quality objective was interpreted into a numeric SSC value for assessing potential impacts to the most sensitive beneficial use (COLD) by analyzing the magnitude and duration of SSCs that produce negligible, behavioral, sub-lethal, and lethal impacts to salmonids (Newcombe and Jenson 1996).

[38] For the Lower Klamath Project water quality analysis, short term is defined as the period during pre-dam removal activities, reservoir drawdown, dam removal, and associated sediment flushing events, which corresponds to pre-dam removal activities that would occur in the one to three years before dam removal, dam removal year 1, dam removal year 2, and post-dam removal year 1 (Table 2.7-1). Long-term is defined as occurring after post-dam removal year 1 (i.e., greater than three years after dam removal.

[39] For the purposes of this report, SSC is considered equivalent to Total Suspended Solids (TSS). SSC and TSS are generally similar, but there are potential differences in the numeric values reported by each method (Gray et al. 2000). As needed, data from multiple sources reported as either TSS or SSC are used interchangeably. SSC is more commonly used in riverine systems while TSS is used for wastewater treatment plants.

Using a generalized "dose-response"[40] approach, the numeric SSCs threshold of significance for potential short-term impacts is 100 mg/L over a continuous two-week exposure period, as this exposure for the duration of two weeks would be a significant adverse impact to salmonids (see Appendix D, Section D.2 for detail).

A more detailed analysis of suspended sediment effects on key fish species, including consideration of specific life history stages, SSCs, and exposure period, is required for a comprehensive assessment of the impacts of the Proposed Project on fisheries-related beneficial uses. This level of analysis is presented in Section 3.3 *Aquatic Resources* and appendices to the section. Further discussion of the particular impacts of suspended sediment on shellfish and estuarine and marine organisms is also presented in Section 3.3.5.1 *Suspended Sediment*.

In the Pacific Ocean nearshore environment, the narrative California marine water quality objectives (Table 3.2-6) are applied as the threshold of significance rather than the freshwater numeric SSCs threshold of significance of 100 mg/L over a continuous two-week exposure period. The freshwater numeric SSCs threshold of significance is not applied to the Pacific Ocean nearshore environment since mixing conditions would potentially result in rapid variations in SSCs and salmonids within the Pacific Ocean nearshore environment would have more of an opportunity to avoid elevated SSCs conditions compared to opportunities within the Klamath River. Due to the fact that turbulent mixing in the Pacific Ocean nearshore environment could result in rapid variations in physical characteristics, including SSCs, the threshold of significance in the marine environment for this EIR is whether the changes in the physical characteristics of the Pacific Ocean nearshore environment would be greater than occurring under natural (i.e., storm) conditions. Variations in the physical characteristics of the Pacific Ocean nearshore environment within the range occurring under natural (i.e., storm) conditions would be similar to existing conditions, so there would be no significant impact. Variations in the physical characteristics of the Pacific Ocean nearshore environment greater than the range occurring under natural (i.e., storm) conditions would potentially cause water quality changes that would result in a failure to maintain existing beneficial uses at the levels currently supported, resulting in a significant impact.

Nutrients

California has a narrative water quality objective for biostimulatory substances and does not stipulate numeric nutrient water quality standards for the COLD beneficial use (Table 3.2-4). California does have numeric nitrate and nitrite standards for the support of municipal beneficial uses (i.e., drinking water). However, these standards are much higher than concentrations that have been measured in the Klamath Basin, such that there is no indication that the municipal beneficial use is not being met or would not be met in the future under the Proposed Project. The Hoopa Valley Tribe and Yurok Tribe also have nitrate standards for municipal beneficial uses (Table 3.2-7) that are similarly high. The Yurok Tribe nitrite water quality objective is discussed under the sub-section *Inorganic and Organic Contaminants* below.

The narrative objective for biostimulatory substances in the Basin Plan applies to all North Coast waters. The California Klamath River TMDLs interpret the narrative

[40] A "dose-response" approach analyzes how exposure to different concentrations over a range of time periods (i.e., hours, days, weeks, months) produces various impacts (i.e., negligible, behavioral, sub-lethal, and lethal) on the organism being evaluated.

biostimulatory substances objective for the Klamath River with numeric targets for nutrients, organic matter, chlorophyll-*a*, *Microcystis aeruginosa*, and microcystin. The numeric TMDL targets for nutrients (TP and TN) and organic matter vary by month and are established for the tailraces of Copco No. 2 and Iron Gate dams. The numeric TP targets range from 0.023–0.029 mg/L for May–October and 0.024–0.030 mg/L for November–April. The numeric TN targets range from 0.252–0.372 mg/L for May–October and 0.304–0.395 mg/L for November–April (North Coast Regional Board 2010). These are established as the monthly mean concentrations that allow achievement of in-reservoir water quality targets to attain the chlorophyll-*a* summer mean target of 10 ug/L, the *Microcystis aeruginosa* cell density target of 20,000 cells/mL, and the microcystin target of 4 ug/L (i.e., avoid nuisance algae blooms in Iron Gate and Copco No. 1 reservoirs) (North Coast Regional Board 2010; see also Appendix D, Section D.1 for a discussion of the "TMDL dams-in" modeling scenario [T4BSRN], which is the basis of these targets).

At multiple locations in the Klamath River, the Klamath River TMDL model results indicate large daily variability in TP and TN in excess of the small range in the monthly TMDL targets, particularly during summer and early fall (generally June–October) (Tetra Tech 2009). As a result, the nutrient impact analysis for this EIR considers whether a general downward (or upward) trend in TP and TN toward (or away from) the numeric targets would occur and, qualitatively, the impact analysis interprets whether such a trend would support or alleviate the growth of nuisance and/or noxious phytoplankton or nuisance periphyton. In the Pacific Ocean nearshore environment, the applicable narrative water quality objective for nutrients would be from the California Ocean Plan that states that nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota (see Table 3.2-6). Thus, the threshold of significance for nutrients is the combination of a qualitative evaluation of potential changes in nutrients under the Proposed Project and an evaluation of whether potential responses in nuisance and/or noxious phytoplankton or nuisance periphyton would impact designated beneficial uses.

Chlorophyll-*a* and Algal Toxins

The Klamath River TMDLs establish a Lower Klamath Project phytoplankton chlorophyll-*a* target of 10 ug/L during the May to October growth season (North Coast Regional Board 2010). The Hoopa Valley Tribe chlorophyll-*a* criterion[41] (150 mg/m^2) relates to periphyton growth rather than phytoplankton growth or algae blooms and it is not discussed further in this section since periphyton growth under the Proposed Project is addressed in Section 3.4 *Phytoplankton and Periphyton*.

The California TMDL target (10 ug/L) is used as the chlorophyll-*a* threshold of significance for Copco No. 1 and Iron Gate reservoirs. Anticipated regular exceedances of these thresholds greater than would occur under existing conditions would constitute a significant impact for this analysis.

For algal toxins, the North Coast Regional Board Basin Plan has narrative water quality objectives for general toxicity that all waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life (North Coast Regional Board 2018). The World

[41] Applicable to the short reach (approximately RM 45) of the Klamath River upstream of the Trinity River.

Health Organization (WHO) has set numeric thresholds for recreational exposures of microcystin toxin at 4 ug/L for a low probability of adverse health effects, and 20 ug/L for a moderate probability of adverse health effects (Falconer et al. 1999; Chorus and Cavalieri 2000). The WHO thresholds are general levels representing a variety of toxigenic cyanobacteria [blue-green algae]. To avoid conditions that lead to water quality impairments, the California Klamath River TMDLs use the WHO low probability of adverse health effects thresholds as targets specific to the California reaches of the Lower Klamath Project for *Microcystis aeruginosa* (less than 20,000 cells/mL) and microcystin toxin (less than 4 ug/L). In addition to the WHO and California Klamath River TMDLs numeric objectives for microcystin toxin thresholds, the CCHAB Network, comprised of the State Water Board, CDPH, and CalEPA OEHHA with participation by multiple federal, state, and local stakeholders, details primary and secondary cyanotoxin [algal toxin] trigger threshold levels for protection of human health in recreational waters in the *Draft Voluntary Statewide Guidance for Blue-Green Algae Blooms* (Table 3.2-10; State Water Board et al. 2010, updated 2016). The minimum primary cyanotoxin [algal toxin] trigger thresholds that would result in a waterbody being posted include 0.8 ug/L total microcystin toxins, detection of anatoxin-a (using an analytical method that detects less than or equal to 1 ug/L), or 1 ug/L cylindrospermopsin. The secondary trigger thresholds are 4,000 cells/mL of all toxin producing species- or site-specific indicators of cyanobacteria [blue-green algae] like blooms, scums, or mats (State Water Board et al. 2010, updated 2016). Additionally, the Hoopa Valley Tribe and Yurok Tribe have numeric objectives for algal toxins. The Hoopa Valley Tribe numeric objectives for algal toxins are less than 1 ug/L total microcystins[42] for drinking water and less than 8 ug/L total microcystins[42] for recreational water (see Table 3.2-7; HVTEPA 2008). The Yurok Tribe has multiple numeric objectives for algal toxins (i.e., microcystin) with the lowest threshold for posting being detection of microcystin (see Table 3.2-11; YTEP 2016).

Table 3.2-10. California Cyanobacteria Harmful Algal Bloom (CCHAB) Trigger Levels for Human Health.

Trigger Level	Primary Triggers[1]			Secondary Triggers	
	Total Microcystins (ug/L)	**Anatoxin-a (ug/L)**	**Cylindrospermopsin (ug/L)**	**Total potentially toxigenic cyanobacteria [blue-green algae] species (cells/mL)**	**Site specific indicators of cyanobacteria [blue-green algae]**
Caution Action	0.8	Detection[2]	1	4,000	Blooms, scums, mats, etc.
Warning TIER I	6	20	4	-	-
Danger TIER II	20	90	17	-	-

Source: (State Water Board et al. 2010, updated 2016)
[1] Primary triggers are met when ANY toxin exceeds criteria
[2] Must use an analytical method that detects less than or equal to 1 ug/L Anatoxin-a

[42] "Total microcystins", as defined in the Hoopa Valley Tribe Surface-Water Objectives, is assumed to be equivalent to "total microcystin" for this EIR.

Table 3.2-11. Yurok Tribe Posting Guidelines for Blue-Green Algae Public Health Advisories

Public Health Advisory Level	*Microcystis aeruginosa* (cells/mL)	Total potentially toxigenic blue-green algae species (cells/mL)	Microcystin toxin Concentration (ug/L)
Caution	Detection	Detection	Detection
Level I Health Advisory Warning	≥ 1,000	≥ 100,000	≥ 0.8
Level II Health Danger Advisory	≥ 5,000	≥ 500,000	≥ 4.0

Source: YTEP (2016)

Since the less than 4 ug/L criterion for microcystin in recreational waters is common to the California Klamath River TMDL, WHO, and Yurok Tribe criteria, and it is less than the Hoopa Valley Tribe recreational criterion, 4 ug/L microcystin is used as the threshold of significance for the Lower Klamath Project EIR water quality analysis. The current lowest CCHAB and Yurok Tribe posting limit for microcystin (0.8 ug/L) is also considered in the analysis although application of the lower threshold would in no case change the significance determinations in this EIR.

While the threshold of significance for microcystin (i.e., algal toxins) is a numeric value, quantitative predictive tools for algal toxins are not available for assessment of the Proposed Project. Therefore, the algal toxin impact analysis is based on a qualitative assessment of whether the Proposed Project would result in exceedances of the criterion and adversely affect human health and recreational beneficial uses. Growth conditions for toxigenic suspended blue-green algae (e.g., nutrient availability, stable, slow-moving water) are considered as part of the qualitative analysis, where predicted changes in nutrient availability, water temperatures, and the availability of stable, slow-moving water (e.g., reservoir) conditions would correspondingly affect algal toxin concentrations.

Inorganic and Organic Contaminants

California has water quality objectives related to inorganic and organic contaminants, with numeric objectives for California's chemical constituents (listed in the Basin Plan [North Coast Regional Board 2018]), and chemical-specific water-column criteria for freshwater and marine aquatic life and human health, including bioaccumulative chemicals such as PCBs, methylmercury, dioxins, and furans (North Coast Regional Board 2018). The most stringent criteria are applied when more than one would be applicable (e.g., freshwater or marine in estuaries with brackish water). California's toxicity and pesticides objectives are narrative (Table 3.2-4).

Thresholds of significance for the California narrative water quality objectives focus on designated beneficial uses and are applicable for contaminants in either the water column or the sediments. For this EIR analysis, establishment of toxicity and/or bioaccumulation potential for sediment contaminants relies upon thresholds developed through regional and state efforts in the Sediment Evaluation Framework for the Pacific Northwest (SEF) (Appendix D – *Section D.3*). The SEF is a regional guidance document that provides a framework for the assessment and characterization of freshwater and marine sediments in Idaho, Oregon, and Washington (RSET 2018). The SEF includes bulk sediment screening levels for standard chemicals of concern and chemicals of special occurrence in marine and freshwater sediments for Idaho, Oregon, and

Washington (RSET 2018). Numeric chemical guidelines for the assessment and characterization of freshwater and marine sediments do not exist for California. Exposures to suspended sediment with elevated concentrations of potentially toxic chemicals are of lower concern for marine receptors than exposures to elevated concentrations of dissolved chemicals since dissolved chemicals are more bioavailable (i.e., able to interact with biological processes) and likely to cause toxicity than chemicals that are bound to sediments and less bioavailable (USEPA 2007). As part of the SEF approach used for the Klamath Dam Removal Secretarial Determination process, bioassays and sediment bioaccumulation tests were conducted to provide additional empirical evidence about the biological effects of inorganic and organic contaminants in reservoir sediment deposits. Bioassays and sediment bioaccumulation test results represent direct exposure to the undiluted reservoir sediments samples, so those results are interpreted based on the expected dilution of reservoir sediments once they are transported from the reservoir footprints under the Proposed Project and potential toxicity from bioassays and sediment bioaccumulation tests are only applied as thresholds of significance after consideration of dilution. Additional information regarding applicable sediment screening levels used for the Klamath Dam Removal Secretarial Determination sediment evaluation process is presented in CDM (2011).

With respect to inorganic and organic contaminants, impacts on water quality are considered significant if the Proposed Project would result in substantive adverse impacts on human health or environmental receptors (e.g., aquatic organisms) due to dam removal. Substantive adverse impacts on human health or environmental receptors is defined as exceedance of applicable chemical screening levels and/or laboratory toxicity results that indicate one or more chemicals are present at levels with potential to cause toxicity after consideration of dilution that would be representative of conditions in the Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environment during and following dam removal. The detection of one or more chemicals at concentrations with potential to cause only minor or limited adverse effects based on exceedances of applicable screening levels and/or laboratory toxicity results after consideration of dilution under the Proposed Project would be below the threshold of significance, thus constitute a less than significant impact. This evaluation is not intended to be equivalent to the SEF process.

Lastly, the Hoopa Valley Tribe and the Yurok Tribe have ammonia toxicity objective based on pH and temperature (Table 3.2-7). Available data suggests no actual ammonia toxicity events associated with the operation of the Lower Klamath Project (North Coast Regional Board 2010), and the turbulent mixing, increased river velocity and expected dissolved oxygen conditions in the river under the Proposed Project would promote an increase in nitrification (i.e., biological oxidation of ammonia and ammonium to nitrate) minimizing the potential for ammonia toxicity. Similarly, the Yurok Tribe has a nitrite water quality objective (Table 3.2-8), but available data does not suggest operation of the Lower Klamath Project influences nitrite concentrations in the Klamath River. Additionally, the rapid oxidation of nitrite to nitrate in the environment combined with the dissolved oxygen and turbulent mixing conditions in the Klamath River would result in any potential nitrite becoming nitrate under the Proposed Project. As a result, these specific objectives are not considered further. Potential short-term toxicity to aquatic organisms during reservoir drawdown, including consideration of ammonia and nitrite toxicity, is addressed using bioassay results (see Section 3.2.4.7 *Inorganic and Organic Contaminants*).

3.2.4 Impact Analysis Approach

Water quality impact analysis considers the Proposed Project's anticipated short-term and long-term water quality effects. For the Lower Klamath Project water quality analysis, short-term is defined as the period during pre-dam removal activities, reservoir drawdown, dam removal, and associated sediment flushing events, which corresponds to pre-dam removal activities that would occur in the one to three years before dam removal, dam removal year 1, dam removal year 2, and post-dam removal year 1 (Table 2.7-1). Long-term is defined as occurring after post-dam removal year 1 (i.e., greater than three years after dam removal).

As these are the areas of greatest potential impact and of most heightened public concern, the water quality analysis in this EIR focuses on the potential impacts of the Proposed Project on water temperature, suspended sediments, nutrients (TN, TP, nitrate, ammonium, ortho-phosphorus), dissolved oxygen, pH and alkalinity, chlorophyll-*a* and algal toxins, and inorganic and organic contaminants in water and reservoir sediments.

While the timing of reservoir drawdown under the Proposed Project was selected to minimize environmental effects, significant short-term impacts are anticipated. In the short term, the water quality impacts are expected to be heavily driven by the release of fine sediment deposits currently stored behind the dams to the downstream river reaches, the Klamath River Estuary, and the Pacific Ocean nearshore environment. Mobilization of reservoir sediment deposits would be most intense during reservoir drawdown and the year following dam removal, when the majority of sediments would be eroded and transported by river flows (Stillwater Sciences 2008; USBR 2012, 2016) (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*). Additionally, there is the potential for short-term water-quality impacts as a result of construction and restoration activities.

Long-term changes in water quality are primarily characterized by the shift from reservoir to river environments in the Hydroelectric Reach and the associated alterations in physical and chemical processes on water quality in this reach and downstream river reaches. Additionally, potential long-term water quality impacts associated with future land use and the transfer of Parcel B lands under the Proposed Project are considered qualitatively.

Multiple numeric models[43] are used for the water quality impact analyses because no one individual existing numeric model captures all of the water quality conditions anticipated for and encompassed by the Proposed Project (Appendix D, Section D.1). Numeric models include those developed by PacifiCorp for the FERC relicensing process for water temperature and dissolved oxygen, North Coast Regional Board models for development of the Klamath River TMDLs, and models used in the course of the Klamath Dam Removal Secretarial Determination studies. While modeling conducted as part of the Klamath Dam Removal Secretarial Determination studies used Water Year (WY) 2012 as the start of the period of analysis for hydrology (i.e., river flows), water temperature, and suspended sediment, the overall range of river flows remains generally consistent between WY 2012 and current conditions (see Section

[43] Here numeric models refers to mathematical models that are developed to represent the physical, chemical, and biological conditions in waterbodies such as rivers, lakes, reservoirs, wetlands, estuaries, and the ocean.

3.1.6 *Summary of Available Hydrology Information for the Proposed Project*) and other modeling assumptions for water temperature and suspended sediment have not changed in the interim. The California Klamath River TMDL models stemmed from a significant five-year effort by the North Coast Regional Board in collaboration with PacifiCorp and working jointly with USEPA Regions 9 and 10 and ODEQ. That work was subject to extensive peer review and public comment before adoption by the North Coast Regional Board. It was further reviewed and subject to additional public comment before being approved unanimously by the State Water Board. It was then subsequently reviewed and approved by the USEPA in December 2010.

The following documents were assessed to determine if the Proposed Project has the potential to conflict with any local policies or ordinances protecting water quality or conflict with provisions of any adopted conservation plans:

- Del Norte County General Plan (Mintier & Associates et al. 2003):
  - Section 1 *Natural Resources/Conservation, Water Resources*, including Policies 1.B.1, 1.B.3, 1.B.6, 1.B.7, and 1.B.12.
- Humboldt County General Plan for Areas Outside of the Coastal Zone (Humboldt County 2017):
  - Water Resources Element, including Policies WR-P1, WR-P2, WR-P3, WR-P4, WR-P5, WR-P12, WR-P18, WR-P22, WR-P23, WR-P24, WR-P25, WR-P29, WR-P33, WR-P34, WR-P35, WR-P36, WR-P37, WR-P39, WR-P42, WR-P43, and WR-P45; Standards WR-S2, WR-S6, WR-S7, and WR-S9; and Implementation Measures WR-IM9, WR-IM14, WR-IM17, WR-IM19, WR-IM20, WR-P28 [sic], WR-IM29, WR-IM30, and WR-IM32.
- Siskiyou County General Plan:
  - Conservation Element (Siskiyou County 1973), including Section 4.H *Watershed and Water Recharge Lands*, Objective and Recommendations 2, 3, and 4; Section 4.I *The [Conservation] Plan*, 1, 4, 8, and Objectives 1, 3, and 5; and Section 5.C.3 *Environmental Impacts*, 1, 3, 5, and 7.
  - Land Use and Circulation Element (Siskiyou County 1980) and Land Use Update (Siskiyou County 1997).

The aforementioned policies, standards, implementation measures, and objectives are stated in general terms, consistent with their overall intent to protect water quality, water resources, and general watershed conditions. In evaluating the potential impacts to specific water quality parameters within the water quality Area of Analysis, including water temperature, suspended sediments, nutrients, dissolved oxygen, pH, chlorophyll-a and algal toxins, and inorganic and organic contaminants, the more general local policies listed above are inherently considered and addressed by the water quality parameter specific analyses in Section 3.2.5 *[Water Quality] Potential Impacts and Mitigation*.

Parameter-specific analysis methods are discussed below.

3.2.4.1 Water Temperature

The analysis of the Proposed Project's potential short-term and long-term impacts on water temperatures is informed by three quantitative models: the Klamath River Water Quality Model (KRWQM), the Klamath River TMDL model, and the RBM10 model. Each of these models includes a scenario that is similar to existing conditions (i.e., with the Lower Klamath Project dams in place) and scenarios with one or more dams removed that are similar to the Proposed Project and/or alternatives analyzed in Section 4 *Alternatives*. The KRWQM was developed for FERC relicensing of the Klamath Hydroelectric Project (PacifiCorp 2004a), and it was later used to inform development of the Klamath River TMDL model. The Klamath River TMDL model was developed to inform the Oregon and California TMDLs. The Klamath River TMDL model includes a "TMDL dams-in" scenario (T4BSRN), which approximates the condition where the Lower Klamath Project dams remain in place, as well as the TOD2RN (Oregon reaches) and TCD2RN (California reaches) scenarios (together the "TMDL dams-out" scenario) that assume the removal of the Lower Klamath Project (see Appendix D for more detail). The Klamath River TMDL model assumes full TMDL implementation for both the dams-in and dams-out scenarios (Tetra Tech 2009); however, the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative. Despite this assumption, the Klamath River TMDL model results are still informative with respect to the analysis of potential water temperature impacts under the Proposed Project, particularly for reaches where the KRWQM was not run for the FERC relicensing process (see Section 3.2.5 *Potential Impacts and Mitigation* for additional discussion). Further, the Klamath "TMDL natural conditions scenario" (T1BSR) is useful for contextualizing water temperature background or natural levels as compared with existing conditions, the Proposed Project, and/or the alternatives. The Klamath River TMDL model assumes that the upstream Keno Dam is replaced by the historical natural Keno Reef in the "TMDL natural conditions" scenario (T1BSR), and the "TMDL dams-out" scenario (TOD2RN and TCD2RN), but not in the "TMDL dams-in" scenario (T4BSRN). Where this assumption applies, the Keno Reach is still partially impounded even though the reef's elevation is two feet lower than the current full pool elevation of Keno Impoundment/Lake Ewauna, which does not materially influence model applicability to inform impact determinations for the Proposed Project and alternatives identified in this EIR.

Since the KRWQM and the Klamath River TMDL model do not include climate change projections or KBRA hydrology[44], one additional set of water temperature modeling results is used for this EIR. The RBM10 model was developed as part of the Klamath Dam Removal Secretarial Determination studies and includes the effects of climate change and KBRA hydrology on water temperatures (Perry et al. 2011). RBM10 model results use climate change predictions from five Global Circulation Models (GCMs) (see Appendix D for more detail). The climate change predictions are used to give additional context to the temperature discussion, but they are not relied on for significance determinations. Future climate changes are not part of the existing condition against which this EIR compares potential impacts under the Proposed Project.

Additional details regarding available numeric models for analysis of long-term water temperature are presented in Appendix D. Table D-1 shows the reaches where KRWQM, Klamath River TMDL, and RBM10 model results are used for the water quality analysis under the Proposed Project and each alternative and Table D-2 presents a

[44] A quantitative comparison between KBRA and the NMFS and USFWS 2013 Joint Biological Opinion for the Klamath Irrigation Project (2013 BiOp Flows) indicates that KBRA Flows sufficiently bracket the range of 2013 BiOp Flows (see also Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*), and so RBM10 model results still generally represent the expected trends under the Proposed Project

comparison of assumptions and parameters for the available numeric models, including flow assumptions. Since no single existing model captures all of the elements analyzed for water temperature in this EIR, model outputs are used in combination to assess similar spatial and temporal trends in predicted water temperature where possible.

3.2.4.2 Suspended Sediments

Reservoir drawdown under the Proposed Project is anticipated to mobilize a large amount of sediment in the short term (USBR 2012). In light of this, the Proposed Project schedules reservoir drawdown during winter months when precipitation, river flows, suspended sediments, and turbidity are naturally highest (see Section 2.7 *Proposed Project*). This EIR uses quantitative modeling and analyses of drawdown to inform the analysis of drawdown's suspended sediment effects, as further described in this section. Additionally, this EIR evaluates the potential for the Proposed Project to affect suspended sediment concentrations over the long-term, using existing data sources and analyses.

Results from the sediment mobility analysis conducted by USBR (2012) for the Klamath Dam Removal Secretarial Determination process are used to provide estimates of short-term SSCs downstream of Iron Gate Dam under the Proposed Project. The sediment mobility analysis used existing suspended sediment data collected by the USGS at the Shasta River near the City of Yreka (USGS gage no. 11517500), Klamath River near Orleans (USGS gage no.11523000), and Klamath River near Klamath (USGS gage no. 11530500) gages to estimate daily total SSCs (measured in mg/L) as a function of flow (measured in cfs) using the SRH-1D sediment transport model (Sedimentation and River Hydraulics–One Dimension Version 2.4) (Huang and Greimann 2010) and the SRH-2D sediment transport model (Sedimentation and River Hydraulics–Two Dimension Version 2.4) (USBR 2012, 2016). Daily total SSCs were modeled for existing conditions representing WY 1961–2008 ("background") and for short-term conditions following dam removal (WY 2020–2021). SRH-1D model output representing total settleable suspended material in the water column, including both inorganic (e.g., silt, clay, and sand) and organic (e.g., algae and plant) suspended material, is applied herein to the suspended sediment analysis. "Suspended sediments" and "suspended material" are used interchangeably to refer to the combined inorganic and organic suspended material. Sources of each type of suspended material differ, as do spatial and temporal trends for each, within the Upper, Middle, and Lower Klamath River reaches (Section 3.2.2.3 *Suspended Sediments*). Bed materials, such as gravels and larger substrates, are discussed in Geology and Soils Section 3.11.5 *Potential Impacts and Mitigation*.

The SRH-1D model assumes drawdown for Copco No. 1 Reservoir begins on November 1 and drawdown for J.C. Boyle, and Iron Gate reservoirs begins on January 1, consistent with the Proposed Project. Copco No. 2 was not explicitly considered in the SRH-1D model, since: 1) construction of Copco No. 2 dam was completed seven years after the substantially larger, upstream Copco No. 1 dam was completed, where the larger dam effectively cut off the source of sediments that would have been transported into Copco No. 2 Reservoir and potentially stored over many years, and 2) Copco No. 2 Reservoir storage volume (70 ac-ft) is negligible compared with that of the upstream Copco No.1 (33,724 ac-ft) and J.C. Boyle (2,267 ac-ft) reservoirs, such that even if sediment deposits were to occur in Copco No. 2 Reservoir during drawdown of upstream Copco No. 1 and J.C. Boyle reservoirs, the smaller Copco No. 2 Reservoir would not meaningfully increase downstream SSCs during designated reservoir drawdown periods (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

The Klamath River hydrology for the SRH-1D model was generated using the Index Sequential method, where historical flow data is used to generate a set of flows under future operational conditions (USBR 2012). Historical flows from 1961 to 2009 (i.e., 49 years of data) were used to estimate potential inflows to the Upper Klamath Lake and Klamath River in the future, then these inflows were routed down the Klamath River based on KBRA flow operations and requirements. In SRH-1D modeling that continued for more than one year (i.e., two years or more), the hydrology in the start year was followed by the hydrology in subsequent years. If there were no subsequent hydrology data (i.e., 2009), the period of record was looped (i.e., 2009 hydrology would be followed by 1961 hydrology) to obtain hydrology for Klamath River inflows for the desired modeling period. For example, if a start year of 2001 was chosen for a two-year modeling period, the hydrology from 2001 and 2002 was used to generate the inflows in the Klamath River that then were routed through the Hydroelectric Reach and further downstream. If a start year of 2001 was chosen for a 51-year modeling period, the hydrology from 2001 to 2009 followed by the hydrology from 1961 to 2002 would be used to generate the inflows in the Klamath River that then were routed through the Hydroelectric Reach and further downstream (USBR 2012).

In addition to modeling the sediment transport during drawdown of the Lower Klamath Project reservoirs, sediment transport in the Klamath River from Iron Gate Dam to the Pacific Ocean for all years between WY 1961 and 2008 was modeled with SRH-1D to estimate the background SSCs in the Klamath River under existing conditions (USBR 2012). Incoming sediment concentrations supplied by tributaries downstream of Iron Gate Dam in the SRH-1D modeling of background SSCs were estimated from existing data on sediment transport and estimates of the sediment delivery rates from portions of the Klamath Basin were used to (Stillwater Sciences 2010; USBR 2012). Additionally, the SRH-1D modeled SSCs were compared with suspended sediment data collected by the USGS on the Shasta River near Yreka, California (USGS 11517500) from 1957 to 1960, on the Klamath River at Orleans, California (USGS 11523000) from 1957 to 1979 and on the Klamath River at Klamath, California (USGS 11530500) from 1974 to 1995 to verify the SRH-1D modeled SSCs sufficiently characterized the background SSCs in the Klamath River at Orleans and Klamath (USBR 2012).

With respect to the assumed reservoir drawdown rate, the USBR (2012) SSC modeling assumes a maximum drawdown rate of 2.25 to 3 feet per day (USBR 2012b) whereas the Proposed Project uses a maximum drawdown rate of 5 feet per day (Appendix B: *Definite Plan*). Stillwater Sciences (2008) modeled a range of drawdown rates (3, 6, and 9 feet per day) for removal of the Lower Klamath Project dams, which spans the aforementioned USBR (2012) and Proposed Project maximum drawdown rates. In Stillwater Sciences (2008), as the drawdown rate increases from 3 to 6 feet per day, the peak concentration of suspended sediments approximately doubles from 10,000 ppm [mg/L] to 20,000 ppm [mg/L], the concentration of suspended sediments decreases more rapidly over the course of days and weeks, and the duration of elevated concentrations decreases by several weeks. A similar response in estimated SSCs is expected for the USBR (2012) model output when increasing the maximum drawdown rate from 2.25 to 3 feet per day to 5 feet per day and accordingly, this response pattern is applied to the analysis of potential impacts due to SSCs, such that no new SSC modeling is required for the Proposed Project. While peak SSCs under the Proposed

Project may be somewhat underestimated by the USBR (2012) modeled SSC results, the SSCs under the Proposed Project would still be within the inherent uncertainty of the USBR (2012) model (i.e., approximately a factor of two). Additionally, a more rapid decrease in suspended sediments and shorter duration of elevated SSCs under the faster drawdown in the Proposed Project would result in the USBR (2012) modeled SSC results underestimating the rate SSCs decrease and overestimate the duration of elevated concentrations in the river, thus the overall UBSR (2012) model results would provide a conservative estimate of the short-term impacts of dam removal on suspended sediments in the Klamath River.

The analysis of short-term suspended sediment-related impacts also considers results from previous studies (e.g., Stillwater Sciences 2010) regarding anticipated sediment release from Klamath River Dam removal within the context of sediment delivery at the broader scale of the Klamath Basin.

The long-term impact analysis of suspended materials uses existing data sources for TSS and turbidity sources to the Hydroelectric Reach and the Middle and Lower Klamath River (e.g., PacifiCorp 2004a, 2004b; YTEP 2005; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016). Existing analyses of the potential effects of dam removal on long-term sediment supply (Stillwater Sciences 2010) are also considered.

3.2.4.3 Nutrients

Under the Proposed Project, short-term nutrient loads associated with high SSCs are assessed in a qualitative manner, considering the likelihood of sediment deposition in the Lower Klamath River, seasonal rates of primary productivity and microbially mediated nutrient cycling, and potential light limitation of primary producers given the high sediment concentrations in the river.

Additionally, the analysis uses Klamath River TMDL model runs to evaluate the general long-term trends (both spatial and temporal) for nutrients in the Hydroelectric Reach and the Middle and Lower Klamath River. The Klamath River TMDL model includes a “TMDL dams-in” scenario (T4BSRN), which approximates the condition where the Lower Klamath Project dams remain in place, as well as the TOD2RN (Oregon reaches) and TCD2RN (California reaches) scenarios (together the “TMDL dams-out” scenario) that assume the removal of the Lower Klamath Project (see Appendix D for more detail). The Klamath River TMDL model assumes full TMDL implementation for both the dams-in and dams-out scenarios (Tetra Tech 2009); however, the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative. Despite this assumption, the Klamath River TMDL model results are still informative with respect to the analysis of potential nutrient impacts under the Proposed Project, particularly since nutrient models were not developed for the FERC relicensing process. To place the Proposed Project analysis in context, results of the “TMDL dams-out” Oregon scenario (TOD2RN) and “TMDL dams-out” California scenario (TCD2RN) are generally interpreted with respect to starting assumptions (i.e., model boundary conditions) about nutrient concentrations. The Klamath River TMDL provides modeling results for all mainstem Klamath River reaches associated with the water quality nutrient analysis for this EIR (see Appendix D, Table D-1).

Long-term trends for nutrients under the Proposed Project are also assessed in this EIR using a prior study of potential nutrient dynamics under a “dams-out” scenario (Asarian et al. 2010). The prior study used nutrient measurements and hydrologic data for the Klamath River, to develop nutrient budgets for June through October of 2005–2008 for the free-flowing reaches of the Klamath River. The prior study included longitudinal trends in absolute and relative retention of TP and TN, and it also compared nutrient retention rates between free-flowing river reaches and reservoir reaches and developed a range of estimates for the degree to which seasonal TP and TN concentrations downstream from Iron Gate Dam might be altered by dam removal. The 2005–2008 study used hydrologic and nutrient data collected by a variety of tribal, federal, and state agencies, and PacifiCorp. The nutrient budget estimates for 2005–2008 improve upon estimates made for the earlier period 1998–2002 (Asarian and Kann 2006a) by using flow- and season-based multiple regression models for predicting daily nutrient concentrations and loads and quantification of uncertainty, relatively lower laboratory reporting limits, higher sampling frequency, and nutrient speciation (not just TN and TP). As compared to the 1998–2002 period, the nutrient budget estimates for 2005–2008 also used improved accounting for peaking flows in the J.C. Boyle Bypass Reach. The effects of dam removal were quantified using calculated relative retention rates in river reaches and comparing them to results from a retention study of Copco No. 1 and Iron Gate reservoirs by Asarian et al. (2009).

3.2.4.4 Dissolved Oxygen

Both short-term and long-term effects on dissolved oxygen levels due to the Proposed Project are analyzed in this EIR. For short-term effects, results of numerical modeling conducted as part of the Klamath Dam Removal Secretarial Determination studies are used to describe predicted short-term dissolved oxygen levels in the Hydroelectric Reach and downstream from Iron Gate Dam due to oxygen demand from mobilized reservoir sediments during dam removal. The one-dimensional, steady-state spreadsheet model uses an approach similar in concept to the Streeter and Phelps (1925) dissolved oxygen-sag equation to incorporate the oxygen-demand offsets of tributary dilution and re-aeration in evaluating the different short-term oxygen demand parameters (e.g., BOD, immediate oxygen demand [IOD], and SOD). The BOD/IOD spreadsheet model also includes chemical oxygen demand generated from the conversion of ammonium and other nitrogenous compounds in reservoir sediments to nitrate under oxic conditions (i.e., when dissolved oxygen levels are 0 mg/L or greater). This is termed nitrogenous oxygen demand and is inherently included in the oxygen demand rate constants used in the BOD/IOD spreadsheet model (Stillwater Sciences 2011).

BOD and IOD are predicted in the spreadsheet model using empirically derived oxygen depletion rates for a particular SSC based on laboratory incubations conducted under the Klamath Dam Removal Secretarial Determination oxygen demand study (Stillwater Sciences 2011). Oxygen depletion rates are scaled to the level of suspended sediments expected under each of the three water year types (typical dry, median, and typical wet water years) considered for the USBR hydrology and sediment transport modeling assessment (see Section 3.2.4.2 *Suspended Sediments*).

The BOD/IOD spreadsheet model assumes drawdown for Copco No. 1 Reservoir begins on November 1 and drawdown for J.C. Boyle and Iron Gate reservoirs begins on January 1, consistent with the Proposed Project (USBR 2012). This would allow maximum SSCs to occur during winter months when flows are naturally high in the mainstem river (Stillwater Sciences 2008, USBR 2012). While Copco No. 1 and Iron

Gate reservoirs exhibit varying degrees of thermal stratification and hypolimnetic anoxia during summer months (see Section 3.2.2.2 *Water Temperature*), all of the reservoirs tend to experience fully-mixed conditions by November/December and remain mixed through April/May. Thus, drawdown beginning in November or January is expected to involve a well-oxygenated water column and inflowing water and, potentially, an oxic sediment top layer. This is important because the spreadsheet model is highly sensitive to background concentrations of dissolved oxygen (Stillwater Sciences 2011), which are generally highest in the Lower Klamath Project reservoirs during winter months (see Section 3.2.2.2 *Water Temperature* and Appendix C). The BOD/IOD spreadsheet model results encompass a six-month period following drawdown in order to estimate potential dissolved oxygen minimum concentrations corresponding to the period of greatest sediment transport in the river under the Proposed Project.

For long-term effects, existing information on water quality dynamics and physical, chemical, and biological drivers for dissolved oxygen concentrations in the Klamath River are used to inform the impacts analysis. Additionally, the analysis of the Proposed Project's potential short-term and long-term impacts on dissolved oxygen is informed by two quantitative models: the Klamath River Water Quality Model (KRWQM) and the Klamath River TMDL model. Both of these models include a scenario that is similar to existing conditions (i.e., with the Lower Klamath Project dams in place) and scenarios with one or more dams removed that are similar to the Proposed Project and/or alternatives analyzed in Section 4 *Alternatives*. The KRWQM was developed for FERC relicensing of the Klamath Hydroelectric Project (PacifiCorp 2004a), and it was later used to inform development of the Klamath River TMDL model. The Klamath River TMDL model was developed to inform the Oregon and California Klamath River TMDLs. The Klamath River TMDL model includes a "TMDL dams-in" scenario (T4BSRN), which approximates the condition where the Lower Klamath Project dams remain in place, as well as the TOD2RN (Oregon reaches) and TCD2RN (California reaches) scenarios (together the "TMDL dams-out" scenario) that assume the removal of the Lower Klamath Project (see Appendix D for more detail). The Klamath River TMDL model assumes full TMDL implementation for both the dams-in and dams-out scenarios (Tetra Tech 2009); however, the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative. Despite this assumption, the Klamath River TMDL model results are still informative with respect to the analysis of potential long-term dissolved oxygen impacts under the Proposed Project, particularly for reaches where the KRWQM was not run for the FERC relicensing process (see Section 3.2.5 *Potential Impacts and Mitigation* for additional discussion).

Additional details regarding available numeric models for analysis of long-term dissolved oxygen are presented in Appendix D. Table D-1 shows the reaches where KRWQM and Klamath River TMDL model results are used for the water quality analysis under the Proposed Project and each alternative and Table D-2 presents a comparison of assumptions and parameters for the available numeric models, including flow assumptions. Since no single existing model captures all of the elements analyzed for dissolved oxygen in this EIR, model outputs are used in combination to assess similar spatial and temporal trends in predicted dissolved oxygen where possible.

3.2.4.5 pH

Short-term effects of the Proposed Project on pH are assessed based on the current understanding of seasonal effects of the Lower Klamath Project reservoirs on pH within the Hydroelectric Reach and the Middle and Lower Klamath River downstream from Iron Gate Dam.

For long-term effects, existing data characterizing pH in the Hydroelectric Reach and the Middle and Lower Klamath River are used to inform the impacts analysis. Additionally, the analysis uses Klamath River TMDL model runs to evaluate the general long-term trends (both spatial and temporal) for pH in the Hydroelectric Reach and the Middle and Lower Klamath River. The Klamath River TMDL model includes a "TMDL dams-in" scenario (T4BSRN), which approximates the condition where the Lower Klamath Project dams remain in place, as well as the TOD2RN (Oregon reaches) and TCD2RN (California reaches) scenarios (together the "TMDL dams-out" scenario) that assume the removal of the Lower Klamath Project (see Appendix D for more detail). The Klamath River TMDL model assumes full TMDL implementation for both the dams-in and dams-out scenarios (Tetra Tech 2009); however, the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative. Despite this assumption, the Klamath River TMDL model results are still informative with respect to the analysis of potential pH impacts under the Proposed Project, particularly since pH models were not developed for the FERC relicensing process. To place the Proposed Project analysis in context, results of the "TMDL dams-in" Oregon scenario (TOD2RN) and "TMDL dams-in" California scenario (TCD2RN) are generally interpreted with respect to starting assumptions (i.e., model boundary conditions) about pH. The Klamath River TMDL provides modeling results for all mainstem reaches associated with the water quality pH analysis for this EIR (see Appendix D, Table D-1).

3.2.4.6 Chlorophyll-a and Algal Toxins

Potential impacts of the Proposed Project on the algal community (phytoplankton, aquatic macrophytes, and periphyton) in the Klamath River are discussed in Section 3.4 *Phytoplankton and Periphyton*. Chlorophyll-*a* is analyzed as a separate water quality parameter in the Lower Klamath Project EIR because it is a surrogate measure of algal biomass and it is a target specific to the Lower Klamath Project reservoirs in the California Klamath River TMDLs (North Coast Regional Board 2010). The Hoopa Valley Tribe water quality objective for chlorophyll-*a* is a measure of attached (benthic) algal growth rather than phytoplankton growth, so it is not discussed further in this section.

Sufficiently accurate quantitative predictive tools for chlorophyll-*a* are not available for the Lower Klamath Project EIR impact analysis. While the California Klamath River TMDLs model includes a chlorophyll-*a* component covering both periphyton and phytoplankton, the model appears to over-predict chlorophyll-*a* under the "dams-out" scenario (Tetra Tech 2008) and is therefore not used for the Lower Klamath Project EIR analysis. The chlorophyll-*a* target (10 ug/L) developed for the Lower Klamath Project reservoirs in the California Klamath River TMDLs is based on a Nutrient Numeric Endpoints (NNE) analysis. The chlorophyll-*a* target of 10 ug/l (i.e. reduction to) is a conservative estimate of mean summer chlorophyll-*a* concentrations required to move the system toward support of beneficial uses (Creager et al. 2006, Tetra Tech 2008).

Instead, this EIR's chlorophyll-*a* impact analysis is based on a qualitative assessment of whether the Proposed Project would result in exceedances of the California 10 ug/L target for the Lower Klamath Project reservoirs and adversely affect beneficial uses with respect to water column concentrations of chlorophyll-*a*. Growth conditions for suspended algae (e.g., nutrient availability, impounded water) are considered as part of the qualitative analysis, where predicted changes in nutrient availability, water temperatures, and the availability of lake or reservoir conditions would correspondingly affect chlorophyll-*a* concentrations.

Since algal toxins are a water quality concern and have the potential to affect designated beneficial uses of water, an analysis of the potential impacts of the Proposed Project on algal toxins as related to water quality standards and beneficial uses is also included in the water quality impacts analysis. There are no quantitative models predicting algal toxin trends under a dam removal scenario, thus the impact analysis is based upon trends in the density of toxin-producing blue-green algae, including *Microcystis aeruginosa,* to algal toxin concentrations (see Section 3.2.2.7 and Appendix C) discerned from data collected in the Hydroelectric Reach and the Middle and Lower Klamath River. This information is considered along with the potential for changes in habitat availability for *Microcystis aeruginosa* (or other toxin-producing blue-green algae) under the Proposed Project.

3.2.4.7 Inorganic and Organic Contaminants

The determination of potential toxicity and bioaccumulation with respect to aquatic species and humans under the Proposed Project is based on the evaluation of existing data characterizing inorganic and organic contaminants associated with both reservoir water quality and sediment deposits, with comparison to thresholds for human and aquatic species exposure.

In particular, the Klamath Dam Removal Secretarial Determination sediment evaluation process followed screening protocols of the Sediment Evaluation Framework (SEF), issued by the interagency Regional Sediment Evaluation Team (RSET) in 2009 and updated in 2018 (Appendix C – *Section C.7*). The RSET is comprised of the USACE (Northwestern Division and Portland, Seattle, and Walla Walla Districts), the USEPA (Region 10), NOAA Fisheries (West Coast Region), USFWS (Pacific Region), ODEQ, Idaho Department of Environmental Quality, Washington Department of Ecology, and Washington Department of Natural Resources. The RSET developed the SEF to provide an approach for evaluating the suitability of sediments for placement in aquatic environments. The SEF involves a data screening assessment to compare reservoir sediment data to available and appropriate sediment maximum levels, screening levels, and bioaccumulation triggers established by the RSET. It also provides guidance for conducting elutriate chemistry (the chemistry of the water between grains of sediment, which can also be referred to as pore water), toxicity bioassays, and bioaccumulation tests, and special evaluations such as tissue analysis and risk assessments (the latter not utilized for this evaluation). The results of the SEF-based evaluation for the 2009–2010 Klamath River sediment samples are used to inform the water quality impacts analysis related to inorganic and organic contaminants under the Proposed Project.

In the Klamath Dam Removal Secretarial Determination process, sediment data were compared to established sediment screening values in a step-wise manner to systematically consider potential impact pathways. Elutriate[45] sample data were also

[45] Elutriate sediment samples were created from reservoir composite sediment samples mixed with reservoir water (e.g., one part sediment to four parts water). In general, elutriate tests are a standard approach that analyzes the chemical composition of the overlying water of the elutriate

evaluated through comparison with a suite of regional, state and federal standards for water quality (CDM 2011). In this EIR, elutriate test results are considered in light of the dilution that would occur under actual conditions during reservoir drawdown.

Biological testing was also conducted during the Klamath Dam Removal Secretarial Determination process using the SEF approach, and the testing consisted of sediment and elutriate toxicity testing and tissue analyses, or other evaluations designed to provide more empirical evidence regarding the potential for sediment contaminant loads to have adverse impacts on receptors (RSET 2009, 2018). While whole sediment toxicity tests identify potential contamination that may affect bottom-dwelling (benthic) organisms, toxicity tests using suspension/elutriates of dredged material assess potential water column toxicity. Bioaccumulation evaluation is undertaken when bioaccumulative chemicals of concern exceed or may exceed sediment screening levels, and thus further evaluation is needed to determine whether they pose a potential risk to human health or ecological health in the aquatic environment (RSET 2009, 2018).

Results from sediment and elutriate sample toxicity bioassays and sediment bioaccumulation tests carried out for the Klamath Dam Removal Secretarial Determination studies are used to provide additional information beyond simple comparisons of sediment contaminant levels to individual-contaminant regional or national screening levels. The results of sediment and elutriate sample toxicity bioassays provide a direct assessment of potential toxicity that takes into account possible interactive effects of mixtures of multiple contaminants, and of potential contaminants that may be present but were not individually measured.

3.2.5 Potential Impacts and Mitigation

Unless otherwise noted, the potential impacts for each water quality parameter are presented in terms of the physical or chemical process that would potentially cause a change in the existing condition. This potential change is then described and analyzed against the applicable significance criteria in Section 3.2.3 *Significance Criteria*, including application of applicable thresholds described in Section 3.2.3.1 *Thresholds of Significance*.

3.2.5.1 Water Temperature

Potential Impact 3.2-1 Short-term and long-term alterations in water temperatures due to conversion of the reservoir areas to a free-flowing river.

Reservoirs and free-flowing rivers have different effects on water temperatures, and these can vary on a seasonal and annual basis with the size (surface area, depth) and shape of the waterbody (see discussion of general effects on water quality from hydroelectric project reservoirs in Section 3.2.2.1 *Overview of Water Quality Processes in the Klamath Basin*). This potential impact evaluates the changes in the water temperature regime that are expected under the Proposed Project against the significance criteria for temperature.

sediment sample in order to estimate potential chemical concentrations in the water between the grains of sediment (pore water). Standard elutriate tests do not reflect the full dilution of re-suspended sediments that would occur during dam removal.

Hydroelectric Reach

The KRWQM did not model water temperatures within the Hydroelectric Reach. Klamath River TMDL model (see Appendix D) results indicate that if the Lower Klamath Project dams were to be removed ("TMDL dams-out, Oregon" [TOD2RN] scenario), water temperatures in the J.C. Boyle Peaking Reach at the Oregon-California state line (RM 214.1) would exhibit slightly lower daily maximum values (0.0–3.6°F) as compared to those predicted under the scenario where the dams remain in place ("TMDL dams-in" [T4BSRN] scenario) (Figure 3.2-7). Temperatures at these locations would also exhibit lower diel (i.e., 24-hour period) water temperature variation during June through September (Figure 3.2-7), and a general trend moving toward a more natural thermal regime (North Coast Regional Board 2010, data from electronic appendices of Asarian and Kann 2006b). The relative difference in diel water temperature variation between these two scenarios would be due to the elimination of peaking operations at J.C. Boyle Powerhouse and the associated large artificial temperature swings that occur in the Klamath River downstream.

Overall, the Klamath River TMDL model results indicate that in the short term and long term, the Proposed Project would decrease maximum summer/fall water temperatures. The Proposed Project would also result in less artificial diel water temperature swings in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir, returning the Klamath River to a more natural thermal regime compared with existing conditions. Elimination of both of these artificial temperature increases would better conform with the California Thermal Plan's prohibition on elevated temperature discharges (Table 3.2-4).

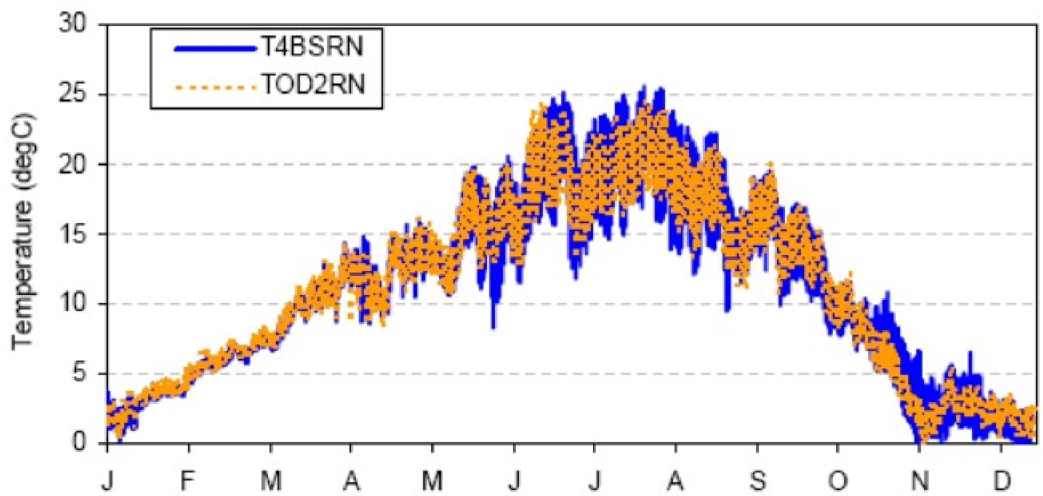

Figure 3.2-7. Predicted Water Temperature at the Oregon-California State Line (RM 214.1) for the Klamath River TMDL Scenarios Similar to the Proposed Project ("TMDL dams-out, Oregon" [TOD2RN] Scenario) and Existing Conditions ("TMDL dams-in" [T4BSRN] Scenario). Source: North Coast Regional Board 2010.

Farther downstream of the J.C. Boyle Peaking Reach (i.e., from Copco No. 1 Reservoir to Iron Gate Dam), the presence of the Lower Klamath Project reservoirs currently decreases spring water temperatures as compared to modeled natural conditions by up to 7°C (13°F) and increases water temperatures as compared to modeled natural conditions by up to roughly 4°C (7°F) (Figure 3.2-3). The Klamath River TMDL model indicates that removal of the Lower Klamath Project under the Proposed Project would eliminate the seasonal temperature shift caused by the Lower Klamath Project reservoirs, returning the Klamath River to a more natural thermal regime. More specifically, the Klamath River TMDL model indicates that just downstream from Copco No. 1 and Copco No. 2 reservoirs (approximately RM 201), removal of the Lower Klamath Project dams would increase daily maximum temperatures to a more natural regime for a period in spring (May and June) and decrease daily maximum temperatures to a more natural regime in late summer/fall (August through October).

Note that the Klamath River TMDL model scenarios are useful for informing impacts associated with the Proposed Project and alternatives identified in Section 4 *Alternatives*, but they include as a starting assumption that there will be full implementation of the TMDLs. For example, the "TMDL dams-in" (T4BSRN) and "TMDL dams-out" (TOD2RN) scenarios for California both assume that water entering into California from Oregon meets California water quality standards for water temperature, organic enrichment/low dissolved oxygen, nutrients, pH, and microcystin. In other words, the starting point for the California models is that all necessary reductions in pollution to address the current impaired conditions at the Oregon-California state line for these constituents would already have been implemented upstream. The full TMDL compliance modeling assumption does not reflect the existing condition, and it would be speculative at this point to identify either the mechanisms necessary to implement the TMDLs or the timing required to achieve full compliance. However, besides the Lower Klamath Project facilities themselves, the temperature point sources (e.g., industrial discharges, sewage treatment plant discharges) located along the Klamath River between Lake Ewauna (approximately RM 257) to upstream of the Shasta River confluence (RM 179.5) have a negligible impact on water temperatures represented in the TMDL model (North Coast Regional Board 2010). Thus, removal of J.C. Boyle Reservoir and its associated hydropower peaking operations, as well as Copco No. 1, Copco No. 2, and Iron Gate reservoirs, dominates the model response. The Klamath River TMDL model illustrates that dam removal would rapidly and substantially move the Hydroelectric Reach towards achieving California TMDL compliance.

Water temperature modeling conducted for the Klamath Dam Removal Secretarial Determination Studies (RBM10) provides generally similar results as the Klamath River TMDL model but includes consideration of future climate change and a KBRA flow regime (see Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* for an assessment of the KBRA and 2013 BiOp flow regimes). Expected increases in summer and fall water temperatures in the Klamath Basin associated with climate change considerations are on the order of 1.8–5.4°F between 2012 and 2061 (Bartholow 2005; Perry et al. 2011). RBM10 model results show a projected shift in the annual temperature cycle that would slightly increase river temperatures in the spring and decrease river temperatures in the late summer/fall in the Hydroelectric Reach under the Proposed Project (Perry et al. 2011; USBR 2016), consistent with the general trend demonstrated by the Klamath River TMDL model results. Further discussion of RBM10 results is presented below for the Middle and Lower Klamath River.

Overall, dam removal under the Proposed Project would cause water temperatures in the Hydroelectric Reach[46] to align with historical anadromous migration and spawning periods for the Klamath River, warming earlier in the spring, and cooling earlier in the fall compared to existing conditions (see also Section 3.3.5.4 *Aquatic Resources – Water Temperature*). The return to a more natural thermal regime compared with existing conditions would align better with the California Thermal Plan's prohibition on increased temperature discharges above natural temperatures and would be beneficial.

Because drawdown of the reservoirs would begin in winter and would be largely complete by spring prior to thermal stratification in the reservoirs, water temperature alterations caused by the Proposed Project in the Hydroelectric Reach as a whole would be beneficial in the short term. As noted above, dam removal would rapidly and substantially move the Hydroelectric Reach towards achieving California TMDL compliance.

In the long term, the Proposed Project would help to decrease temperatures in the late summer/fall in the Hydroelectric Reach as a whole when climate change is expected to increase summer and fall water temperatures in the Klamath Basin on the order of 1.8–5.4°F between 2012 and 2061 (Bartholow 2005; Perry et al. 2011).

In summary, under the Proposed Project, the anticipated increases in springtime water temperatures in the Hydroelectric Reach as a whole and decreases in diel temperature variation in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir, would return the Klamath River to a more natural thermal regime compared with existing conditions. The projected decreases in late summer/fall water temperatures in the Hydroelectric Reach as a whole also would return the Hydroelectric Reach to a more natural thermal regime compared with existing conditions and would align better with the California Thermal Plan's prohibition on increased temperature discharges above natural temperatures. These effects would be beneficial in the short term and would rapidly move the Hydroelectric Reach towards achieving California TMDL compliance. In the long term, the beneficial effects would also help to offset the impacts of climate change on late summer/fall water temperatures.

Middle and Lower Klamath River, Klamath River Estuary, and Pacific Ocean Nearshore Environment

Water temperature modeling results are available for the Middle and Lower Klamath River downstream of Iron Gate Dam from three separate modeling efforts: the PacifiCorp relicensing efforts (KRWQM); development of the California Klamath River TMDLs; and water temperature modeling conducted for the Klamath Dam Removal Secretarial Determination studies (RBM10). For more information on these models, please see Section 3.2.4.1 *Water Temperature* (overview) and Appendix D (detailed). KRWQM results comparing existing conditions (all Lower Klamath Project dams in place) to four without-project scenarios[47] for 2001–2004 indicate that the reservoirs create a temporal

[46] Under existing conditions, anadromous fish do not migrate into or spawn in the Hydroelectric Reach due to the fish passage barriers caused by the Lower Klamath Project dams. Under the Proposed Project, these barriers would be removed.

[47] The four without-project scenarios are: 1) without Lower Klamath Project dams and Keno Dam; 2) without Iron Gate Dam; 3) without Copco No. 1, Copco No. 2, and Iron Gate dams; and 4) without J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams (most similar to the Proposed Project).

shift by releasing generally cooler water from mid-January to April, variably cooler or warmer water from April through early August, and warmer water from August through November (PacifiCorp 2004a, Dunsmoor and Huntington 2006). Just downstream from Iron Gate Dam, this translates to an approximately 2°F to 5°F cooling during spring and an approximately 4°F to 18°F warming during summer and fall (Figure 3.2-8). Immediately upstream of the confluence with the Scott River (RM 145.1), the difference between existing conditions and the dam removal scenario modeled using the KRWQM indicates a lesser, albeit still measurable, warming of approximately 4°F to 9°F for most of October and November (Figure 3.2-9). Because patterns in reservoir thermal structure for Iron Gate and Copco No. 1 reservoirs indicate that stratification generally starts in April and ends in November, the effect of reservoir thermal regime on downstream water temperatures appears to be cooling during non-stratified periods and warming during stratified periods.

The KRWQM model results also indicate that reservoir thermal regimes under existing conditions act to reduce the magnitude of diel temperature variation compared with natural conditions in the river reaches immediately downstream from Iron Gate Reservoir (RM 193.1; see Figure 3.2-8) (Deas and Orlob 1999, PacifiCorp 2005). As with the seasonal temperature effect, the dampening influence on diel temperature variation is considerably diminished farther downstream, at the confluence with the Scott River (RM 145.1; see Figure 3.2-9). The KRWQM indicates that the overall water temperature influence of the Hydroelectric Reach is mostly attenuated by RM 66.3 at the confluence with the Salmon River (see Figure 3.2-10).

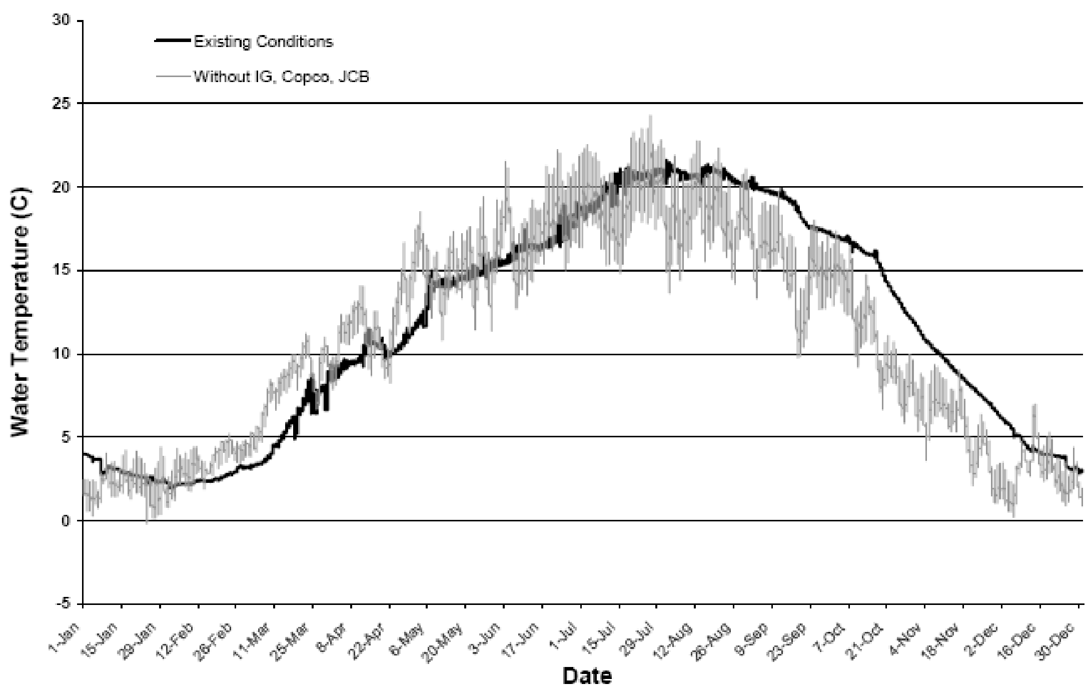

Figure 3.2-8. Simulated Hourly Water Temperature Downstream from Iron Gate Dam Based on Year 2004 for Existing Conditions Compared to Hypothetical Conditions without J.C. Boyle (JCB), Copco No. 1, Copco No. 2, and Iron Gate (IG) Dams. Source: PacifiCorp 2005.

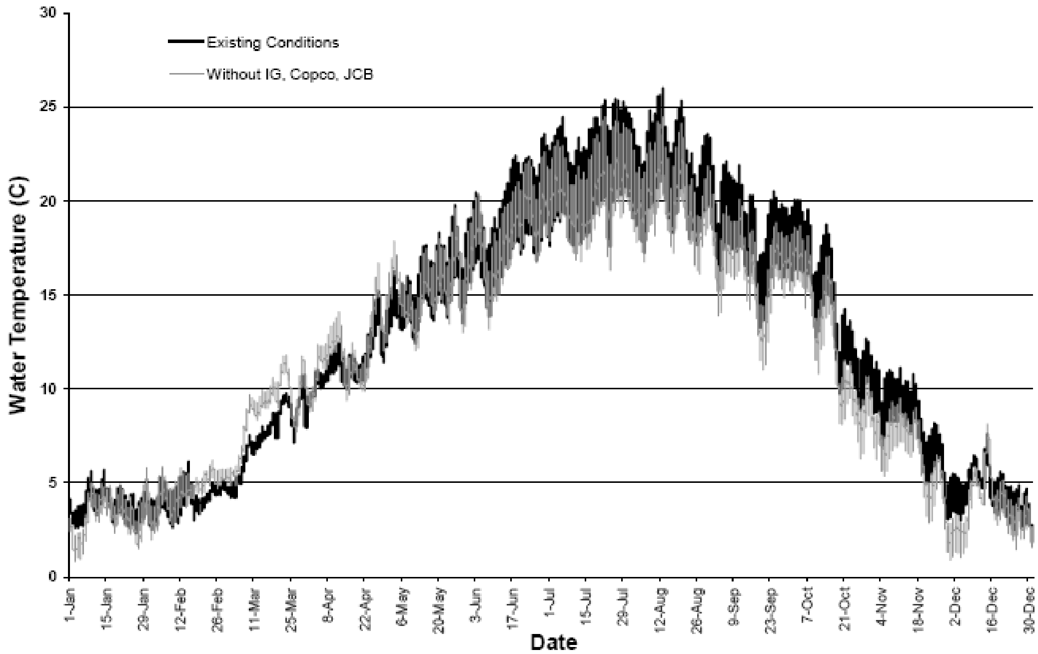

Figure 3.2-9. Simulated Hourly Water Temperature Immediately Upstream of the Scott River Confluence (RM 145.1) Based on Year 2004 for Existing Conditions Compared to Hypothetical Conditions without J.C. Boyle (JCB), Copco No. 1, Copco No. 2, and Iron Gate (IG) Dams. Source: PacifiCorp 2005.

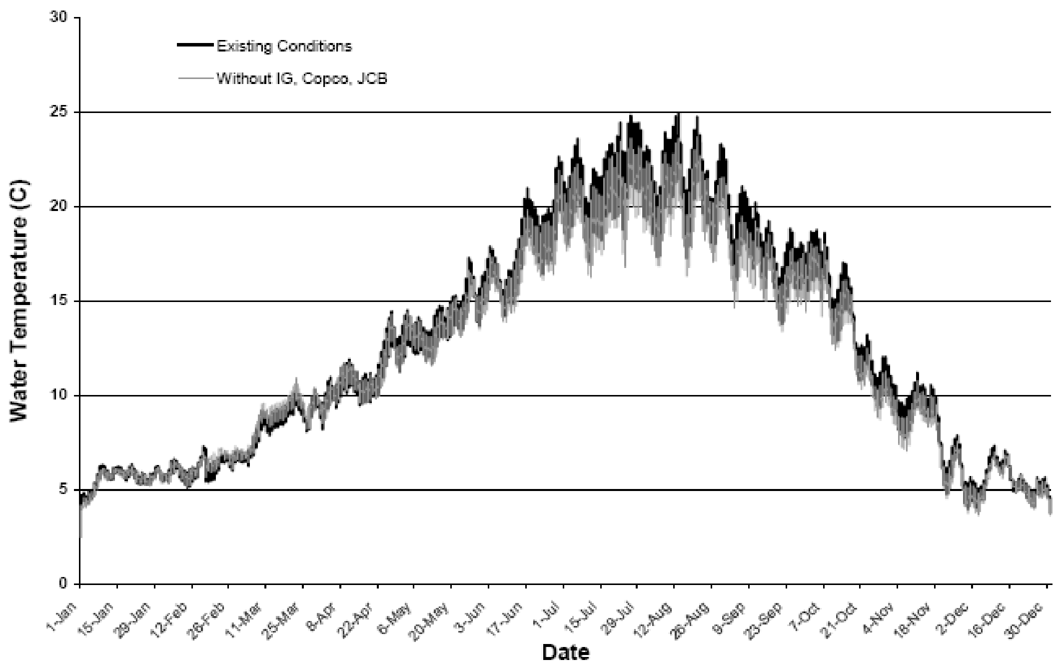

Figure 3.2-10. Simulated Hourly Water Temperature Downstream from the Salmon River Confluence (≈RM 66.3) Based on Year 2004 for Existing Conditions Compared to Hypothetical Conditions without J.C. Boyle (JCB), Copco No. 1, Copco No. 2, and Iron Gate (IG) Dams. Source: PacifiCorp 2005.

In agreement with KRWQM results, Klamath River TMDL model results also indicate that if the Lower Klamath Project dams were to be removed ("TMDL dams-out, California" [TCD2RN] scenario), then water temperature in the Klamath River downstream from Iron Gate Dam would be lower (by 4°F to 18°F) during August through November and higher (by 4°F to 9°F) during January through March (dams remaining in place would be the "TMDL dams-in" [T4BSRN] scenario) (North Coast Regional Board 2010). The Klamath River TMDL model also predicts that diel variation in water temperature downstream from Iron Gate Dam during these same periods would be greater for a dam removal scenario ("TMDL dams-out, California" [TCD2RN]) than a dams in-place scenario ("TMDL dams-in" [T4BSRN]) because river water temperatures would be in equilibrium with, and would reflect, diel variation in ambient air temperatures rather than being dominated by the large thermal mass of, and stratification patterns in, the reservoirs. Note that the Klamath River TMDL model for both "dams-in" and "dams-out" scenarios assumes full implementation of the TMDLs, a condition that is currently highly speculative with respect to the mechanisms and timing required to achieve future compliance. However, besides the Lower Klamath Project facilities themselves, because the temperature point sources (e.g., industrial discharges, sewage treatment plant discharges) located along the Klamath River between Lake Ewauna (approximately RM 257) to upstream of the Shasta River confluence (RM 179.5) have a negligible impact on water temperatures represented in the Klamath River TMDL model (North Coast Regional Board 2010), removal of the Lower Klamath Project reservoirs dominates model response for the referenced point downstream of Iron Gate Dam. Further, although the Klamath River TMDL model assumes full implementation of the Scott River TMDL (North Coast Regional Board 2005) and the Shasta River TMDL (North Coast Regional Board 2006) for the "dams-out" scenario, it also assumes full implementation of these major tributary TMDLs for the "dams-in" scenario, such that in the reach downstream of Iron Gate Dam, the only difference between the two model scenarios is the removal of the Lower Klamath Project. Thus, even under the assumption of full TMDL compliance, the model illustrates that dam removal would rapidly and substantially move the Klamath River downstream of Iron Gate Dam towards achieving TMDL compliance.

As with KRWQM, the Klamath River TMDL model indicates that the temperature effects of removing the Lower Klamath Project would decrease in magnitude with distance downstream from Iron Gate Dam, and they would not be evident in the reach downstream from the Salmon River confluence (approximately RM 66.3) (North Coast Regional Board 2010; Dunsmoor and Huntington 2006). Therefore, under a dam removal scenario that also assumes full TMDL implementation ("TMDL dams-out, California" [TCD2RN] scenario), water temperatures would not be directly affected in the Middle Klamath River downstream from the confluence with the Salmon River and would not affect temperatures farther downstream in the Lower Klamath River, the Klamath River Estuary, or the Pacific Ocean nearshore environment.

As part of the Klamath Dam Removal Secretarial Determination studies, the effects of climate change and of KBRA flows (which, as discussed in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* sufficiently bracket the range of flows under the existing condition*)* were included in projections for future water temperatures under the Proposed Project using the RBM10 model. RBM10 model results using climate change predictions from five GCMs indicate that future water temperatures under the Proposed Project and climate change would be 1.8–4.1°F warmer than historical temperatures (Perry et al. 2011). This temperature range is slightly lower than that suggested by projecting Bartholow (2005) historical (1962–2001) estimates of 0.09°F per year, or approximately 4°F to 5°F over 50 years. However, within the general uncertainty of climate change projections, results from the two models correspond reasonably well and indicate that water temperatures in the Upper Klamath Basin are expected to increase on the order of 2°F to 5°F between 2012 and 2061.

RBM10 results also indicate that, even with warming of water temperatures under climate change, the primary long-term effect of dam removal downstream of Iron Gate Dam is still anticipated to be the return of approximately 126 miles of the Middle Klamath River, from Iron Gate Dam (RM 193.1) to the Salmon River (RM 66), to a more natural thermal regime (Perry et al. 2011). Model results indicate that the annual temperature cycle downstream from Iron Gate Dam would shift forward in time by approximately 18 days under the Proposed Project, with warmer temperatures in spring and early summer and cooler temperatures in late summer and fall immediately downstream from the dam. Just downstream from Iron Gate Dam, water temperatures under the Proposed Project, including climate change, would average approximately 4°F greater in May, while during October water temperatures would average approximately 7°F cooler. At the confluence with the Scott River, the differences would be diminished, but there would still be a slight warming in the spring (May) with average water temperatures approximately 2°F greater and a slight cooling in the fall (October) with average water temperatures approximately 4°F less. Water temperature changes from the Proposed Project would be less than 1°F at the confluence with the Salmon River (RM 66) in agreement with the Klamath River TMDL model results (Perry et al. 2011). Thus, despite the anticipated warming under climate change, long-term water temperature improvements under the Proposed Project would support continued achievement of the California temperature TMDLs for the mainstem Klamath River.

All of the existing water temperature model projections (KRWQM, TMDL, RBM10) indicate that dam removal under the Proposed Project would cause water temperatures in the Middle Klamath River to align better with historical anadromous migration and spawning periods for the Klamath River, warming earlier in the spring, and cooling earlier in the fall compared to existing conditions. Warmer springtime temperatures would result in fry emerging earlier, encountering favorable temperatures for growth sooner than under existing conditions, which could support higher growth rates and encourage earlier outmigration downstream, similar to what likely occurred under historical conditions, and reduce stress and disease (Bartholow et al. 2005, FERC 2007). In addition, fall-run Chinook salmon spawning in the mainstem Klamath River during fall would no longer be delayed (reducing pre-spawn mortality), and adult migration would occur in more favorable water temperatures than under existing conditions. Overall, these changes would result in water temperatures more favorable for salmonids in the mainstem Klamath River downstream from Iron Gate Dam (see also Section 3.3.5.4 *Aquatic Resources – Water Temperature*). The return to a more natural thermal regime compared with existing conditions would align better with the California Thermal Plan's prohibition on increased temperature discharges above natural temperatures and would be beneficial.

As drawdown of the Lower Klamath Project reservoirs would begin in winter and would be largely complete by spring prior to thermal stratification in the reservoirs, the water temperature alterations resulting from dam removal under the Proposed Project in the Klamath River downstream from Iron Gate Dam would occur, either partially or fully, within the first one to two years following dam removal and would be considered short-term benefits. As noted above, removal of the Lower Klamath Project Reservoirs would rapidly and substantially move the Klamath River downstream of Iron Gate Dam towards achieving TMDL compliance. Additionally, water temperature alterations due to the Proposed Project would continue beyond three years following dam removal so they would also be long-term benefits. The Proposed Project's temperature benefits on late summer/fall water temperatures may be of additional assistance in helping to offset the impacts of climate change on late summer/fall Klamath River water temperatures.

In summary, under the Proposed Project, the short-term and long-term increases in spring water temperatures, increased diel temperature variation, and decreases in late summer/fall water temperatures in the Middle Klamath River for the reach from Iron Gate Dam to the confluence with the Salmon River would be beneficial. There would be no impact for water temperatures in the Middle Klamath River downstream from the Salmon River, Lower Klamath River, Klamath River Estuary, or Pacific Ocean nearshore environment.

The Definite Plan (see Appendix B: *Definite Plan – Appendix M*) includes a Water Quality Monitoring Plan to assess the Proposed Project's impacts to water quality, and this plan includes temperature monitoring. The State Water Board has authority to review and approve any final Water Quality Monitoring Plan through its water quality certification under Clean Water Act Section 401. The State Water Board has issued a draft water quality certification which sets forth monitoring and adaptive management requirements for any Water Quality Monitoring Plan to meet, as Condition 1[48]. Additionally, the Oregon Department of Environmental Quality has issued a final water quality certification[49] that sets forth water quality monitoring and adaptive management conditions for points upstream of California. The effect of the Proposed Project on water temperature is anticipated to be beneficial in both the short and long term, and this analysis of Potential Impact 3.2-1 does not further discuss the water quality monitoring and adaptive management conditions.

Significance

Beneficial for the Hydroelectric Reach and the Middle Klamath River to the confluence with the Salmon River, in the short term and in the long term

No significant impact for the Middle Klamath River downstream from the Salmon River, Lower Klamath River, Klamath River Estuary, and Pacific Ocean nearshore environment in the short term or the long term

Potential Impact 3.2-2 Short-term and long-term alterations in seasonal water temperatures in the Klamath River Estuary due to morphological changes induced by dam removal sediment release and subsequent deposition in the estuary.
Increased sediment deposition in the Klamath River Estuary due to sediment releases from dam removal may change the shape of the estuary in a way that could impact water temperatures. Such morphological changes could be from, for example, shifted

[48] The State Water Board's draft water quality certification is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 11, 2018).

[49] The Oregon Department of Environmental Quality's final water quality certification is available online at: https://www.oregon.gov/deq/FilterDocs/ferc14803final.pdf (Accessed December 14, 2018).

bed elevations or changes to the contours of the bottom of the estuary. The amount of sediment deposition in the estuary as a result of dam removal is anticipated to be small, as sediment release would coincide with and be driven by high flows associated with dam removal; therefore, sediment deposition in the estuary associated with dam removal is not expected to be widespread, but it would occur in backwaters or vegetated areas, if at all (Stillwater Sciences 2008, USBR 2012) (see also Potential Impact 3.11-5). Morphological changes that decrease the depth of Klamath River Estuary waters or the volume of the estuary waters could result in more solar radiation being absorbed by a smaller water volume, which would tend to increase estuary water temperatures. Additionally, morphological changes that reduce estuary mixing conditions can produce more backwater or slack water areas within the estuary. This could effectively reduce the amount of water absorbing solar radiation in these areas and could result in localized warming of estuary water in those backwater or slack water areas. Sediment deposition also could result in morphological changes that decrease the size of the salt wedge, either by increasing the frequency of mouth closure, or by elevating the bottom of the estuary above portions of the tidal range when the mouth is open. All of these morphological changes due to sediment deposition could potentially result in an increase in Klamath River Estuary water temperatures over the existing condition.

Estuary waters provide optimal habitat for juvenile salmonids that use the estuary to rear prior to returning to the Pacific Ocean. Additionally, the Klamath River Estuary is designated as critical habitat for Southern Oregon/Northern California Coast (SONCC) evolutional significant unit for coho salmon (NMFS 1999) and would benefit for cooler water temperatures. Sediment scouring would increase the estuary depth, the size of the estuary, the mixing conditions, and/or the size of salt wedge, so the volume of water absorbing solar radiation would increase and estuary water temperatures would not be expected to increase. Therefore, should sediment scouring occur in association with the Proposed Project, it would be unlikely to increase short-term or long-term water temperature conditions in the Klamath River Estuary.

Under existing conditions, high concentrations of silt and clay are transported through the estuary on an annual basis. Sediment sampling by USBR (2010) documented the absence of fine material in the estuary except in the backwater and vegetated areas (see Section 3.11.2.4 *Sediment Load* for more details). Modeling of sediment transport due to reservoir drawdown indicates that only fine sediments (silts, clays, and organics) would be transported to the estuary, and fine sediments would not deposit in significant quantities in the estuary (USBR 2012). If dam removal occurs under dry water years conditions, small volumes of fine sediment may deposit in the backwater and vegetated areas in the estuary due to lower river flows in dry water years (USBR 2012). However, even under this scenario, since limited sediment deposition is expected to occur in the Klamath River Estuary as a result of the Proposed Project (see Potential Impact 3.11-6), small morphological changes in the estuary that may occur due to dam removal sediment releases would not be likely to increase short-term estuary water temperatures in an manner that would cause or substantially exacerbate an exceedance of water quality standards or would result in a failure to maintain existing beneficial uses currently supported.

With respect to the potential for long-term impacts, estimates of baseline sediment delivery for the Klamath Basin indicate that sediment delivery rates would not change substantially under the Proposed Project (Stillwater Sciences 2010) (see also Potential

Impact 3.11-5). Accordingly, there would be no long-term morphological changes in the estuary that would affect water temperatures under the Proposed Project.

As discussed above for Potential Impact 3.2-1, the State Water Board has issued a draft water quality certification which sets forth proposed water quality monitoring and adaptive management requirements for the Proposed Project, as Condition 1[50].

Significance

No significant impact

3.2.5.2 Suspended Sediments

For the purposes of the Lower Klamath Project EIR, "suspended sediment" refers to settleable suspended material in the water column. Bed materials, such as gravels and larger substrates, are discussed in Geology and Soils Section 3.11.5 *Potential Impacts and Mitigation*. Two types of suspended material are considered for water quality impacts in the Klamath River: algal-derived (organic) suspended material and mineral (inorganic) suspended material. Sources of each type of suspended material differ, as do spatial and temporal trends for each, within the Upper, Middle, and Lower Klamath River reaches (see Section 3.2.2.3 *Suspended Sediments*).

Potential Impact 3.2-3 Increases in suspended sediments due to release of sediments currently trapped behind the dams.

Increases in suspended sediment due to release of reservoir sediments currently trapped behind the Lower Klamath Project dams are discussed by Klamath River reach below. As discussed in Section 3.2.4.2 *Suspended Sediments*, the analysis for this EIR interprets USBR (2012) modeled suspended sediment concentrations (SSCs) during and after reservoir drawdown, based on KRRC's proposed reservoir drawdown rates, where the latter would increase peak SSCs, increase the rate SSCs would decrease, and decrease the overall duration of elevated SSCs relative to the drawdown rates that were previously modeled (USBR 2012). While the USBR (2012) model results would underestimate peak SSCs relative to the KRRC's Proposed Project, the modeled SSCs provide a conservative estimate of the short-term impacts of suspended sediment releases due to dam removal since the underestimate of peak SSCs would still be within model uncertainty (i.e., approximately a factor of two) and model results would overestimate the duration of elevated SSCs.

Additionally, the Proposed Project would support erosion and transport of sediments deposited within the Copco No. 1 and Iron Gate reservoir footprints by using barge-mounted pressure sprayers to jet water onto newly exposed reservoir-deposited sediments as the water level decreases during drawdown, a process called sediment jetting. The barge-mounted pressure sprayers would use water from the reservoir, so sediment jetting would only be conducted when reservoir levels are sufficiently high to safely operate the barge and no sediment jetting would occur once reservoir drawdown is complete. Sediment jetting would maximize the erosion of reservoir-deposited sediments during drawdown within the six areas where restoration actions are proposed within the Copco No. 1 Reservoir footprint (Figure 2.7-11) and the three areas where

[50] The State Water Board's draft water quality certification is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 11, 2018).

restoration actions are proposed within the Iron Gate Reservoir footprint (Figure 2.7-12). Sediment jetting would also minimize the potential for reservoir sediment erosion and the associated increase in SSCs outside of the reservoir drawdown period by mobilizing sediments during drawdown. While sediment jetting would primarily transport reservoir deposited sediments that are already anticipated to be eroded during drawdown, some additional reservoir deposited sediments may be transported by the combination of drawdown and sediment jetting flows compared to only drawdown flows. The total sediment behind the dams by 2020[51] and the range of sediment volume anticipated to erode from each reservoir during dam removal was estimated by USBR (2012) as part of the sediment transport modeling. The range of sediment volume that potentially would be transported from sediment jetting during drawdown was estimated for Copco No. 1 and Iron Gate reservoirs from the approximate areas where the restoration actions would occur in the individual reservoirs (Figure 2.7-8 and 2.7-9) and the maximum and minimum sediment depths measured in the vicinity of those restoration actions. Sediment depths were measured in sediment cores taken by Shannon and Wilson (2006) and USBR (2009) and summarized in USBR (2012). Sediment jetting during drawdown would potentially transport between approximately 13 and 41 percent of the sediment volume expected to erode during dam removal (Table 3.2-12).

[51] Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur under the KRRC's revised schedule), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable to the Proposed Project.

Table 3.2-12. Estimated Range of Sediment Volume Transported by Sediment Jetting During Drawdown Compared to Total Sediment Volume Anticipated to Erode with Dam Removal.

Reservoir	Total 2020 Sediment Volume[1,2,3] (cubic yards)	2020 Sediment Volume Erosion[3,4] (cubic yards)		Estimated 2020 Sediment Volume Transported by Sediment Jetting[3,5] (cubic yards)		Percentage of 2020 Sediment Volume Transported by Sediment Jetting (%)	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Copco No. 1	8,250,000	3,713,000	6,270,000	970,000	1,278,000	15%	34%
Iron Gate	5,690,000	1,366,000	1,821,000	237,000	554,000	13%	41%

1 Total 2020 sediment volume is from USBR (2012) which estimated the total sediment volume from the sediment cores taken in the individual reservoirs and projected to 2020 based on annual sedimentation rates for each reservoir.
2 Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable to the Proposed Project.
3 Rounded to nearest 10,000 cubic yards.
4 Sediment volume erosion is based on the USBR (2012) estimated total 2020 sediment volume and erosion rates during drawdown. The maximum and minimum erosion rates for each reservoir (see Table 2.7-11) are based on hydrologic conditions recorded for the March to June flow volume at Keno gage on the Klamath River from water year 2001 (90 percent exceedance) and 1984 (10 percent exceedance). Sediment volume from individual reservoirs may not equal the total amounts indicated because masses taken from USBR (2012) were rounded to the nearest 10,000 tons.
5 Sediment volume erosion transported by sediment jetting is estimated from the approximate areas where restoration actions would occur in the individual reservoirs (Figure 2.7-8 and 2.7-9) and the maximum and minimum sediment depth measured in the vicinity of those restoration actions.

SSCs that would occur during reservoir drawdown under the KRRC's Proposed Project would increase relative to the prior model results (USBR 2012) due to the influence of sediment jetting, while SSCs after drawdown completes are expected to be similar or less than the modeled SSCs since sediment jetting would increase transport of reservoir sediments during drawdown and less sediment would remain in the reservoir after drawdown. Variations in SSCs downstream of Copco No. 1 and Iron Gate reservoirs due to sediment jetting within the reservoir footprint are discussed in the relevant reaches below.

Hydroelectric Reach

Sediment transport modeling of the impacts of dam removal indicate high short-term SSCs in the Hydroelectric Reach under the Proposed Project (Stillwater Sciences 2008; USBR 2012, 2016). Modeled SSCs downstream of J.C. Boyle Reservoir would be high in the short term, but concentrations would be considerably less than those anticipated to occur downstream from Copco No. 1 and Iron Gate reservoirs due to the relatively small volume of the sediment deposits behind J.C. Boyle Dam (eight percent of total volume for the Lower Klamath Project, see also Tables 2.7-7 and 2.7-8). Model output indicates that SSCs immediately downstream of J.C. Boyle Dam under dry (WY 2004), median (WY 1968), and wet (WY 1999) water year types would exhibit peak values of 2,000–3,000 mg/L occurring within one to two months of reservoir drawdown. Model results indicate SSCs greater than 100 mg/L for two weeks or more would potentially occur downstream of J.C. Boyle Dam for one to three months under the Proposed Project, coinciding with the drawdown period. During these one to three months, modeled SSC exceed 100 mg/L over two weeks for several non-consecutive periods, with SSCs remaining above 100 mg/L for approximately two to seven consecutive weeks depending on the water year. The suspended sediments released from J.C. Boyle Reservoir would quickly move into the California portion of the Hydroelectric Reach. SSCs exceeding 100 mg/L for two consecutive weeks was selected as a threshold of significance because exposure for SSCs above 100 mg/L for two weeks would be a significant adverse impact to cold-water fishery species (i.e., salmonids, including rainbow trout) and associated designated beneficial uses, including cold freshwater habitat (COLD), rare, threatened, or endangered species (RARE), and migration of aquatic organisms (MIGR) in the Hydroelectric Reach (see Section 3.2.3.1 *Thresholds of Significance, Suspended Sediment*). Modeled SSCs downstream of J.C. Boyle Dam are greater than 100 mg/L for two consecutive weeks during drawdown, thus there would be a significant impact to SSCs in the short term in the Hydroelectric Reach due to increases in suspended sediment from releases of sediment trapped behind J.C. Boyle Dam. Modeled SSCs decrease to less than 100 mg/L within five to seven months following drawdown, and concentrations further decrease to less than 10 mg/L within six to 10 months following drawdown of J.C. Boyle Reservoir (Figure 3.2-11 through Figure 3.2-13).

The higher drawdown rate under the Proposed Project than under modeled conditions is expected to increase peak SSCs and decrease the duration of elevated SSCs compared to modeled SSCs (see Section 3.2.4.2 *Suspended Sediments*), but variations in modeled SSCs due to a higher drawdown rate would be unlikely to reduce the duration of SSCs above 100 mg/L to less than two consecutive weeks under all water years types. Peak SSCs would be expected to double from approximately 2,000 – 3,000 mg/L under modeled conditions to approximately 4,000–6,000 mg/L under the higher drawdown rate in the Proposed Project, based on a previous analysis how suspended sediments vary under different drawdown rates in Lower Klamath Project reservoirs (Stillwater Sciences 2008). A higher drawdown rate would also be expected to decrease the duration of elevated SSCs by approximately one to two weeks (Stillwater Sciences). Modeled SSCs greater than 100 mg/L downstream of J.C. Boyle Dam occur for up to seven consecutive weeks, depending on the water year type (see Figure 3.2-11 to Figure 3.2-13), so SSCs under the Proposed Project with a higher drawdown rate would be likely to remain greater than 100 mg/L for two consecutive weeks. However, SSCs after drawdown would potentially decrease to less than 10 mg/L more rapidly under the Proposed Project than estimated by the modeled SSCs. Overall, the short-term impact based on an analysis of modeled SSCs downstream of J.C. Boyle Dam would remain the same under the higher drawdown rate in the Proposed Project since SSCs is expected to exceed 100 mg/L for two consecutive weeks regardless of the drawdown rate.

In the year following dam removal year 2 (post-dam removal year 1), modeling indicates suspended sediments would not be greater than 100 mg/L over a continuous two-week period under all water-year types. In dry and normal water-year types, modeled suspended sediment concentrations were always below 100 mg/L during post-dam removal year 1. In wet water-year types, the modeled suspended sediment concentrations are usually less than 100 mg/L during post-dam removal year 1, but there is an approximately one-week period when modeled suspended sediment concentrations are greater than 100 mg/L associated with storm conditions. Modeling indicates the suspended sediment concentrations return to modeled background levels (i.e., existing conditions) under all water year types during post-dam removal year 1 (USBR 2012).

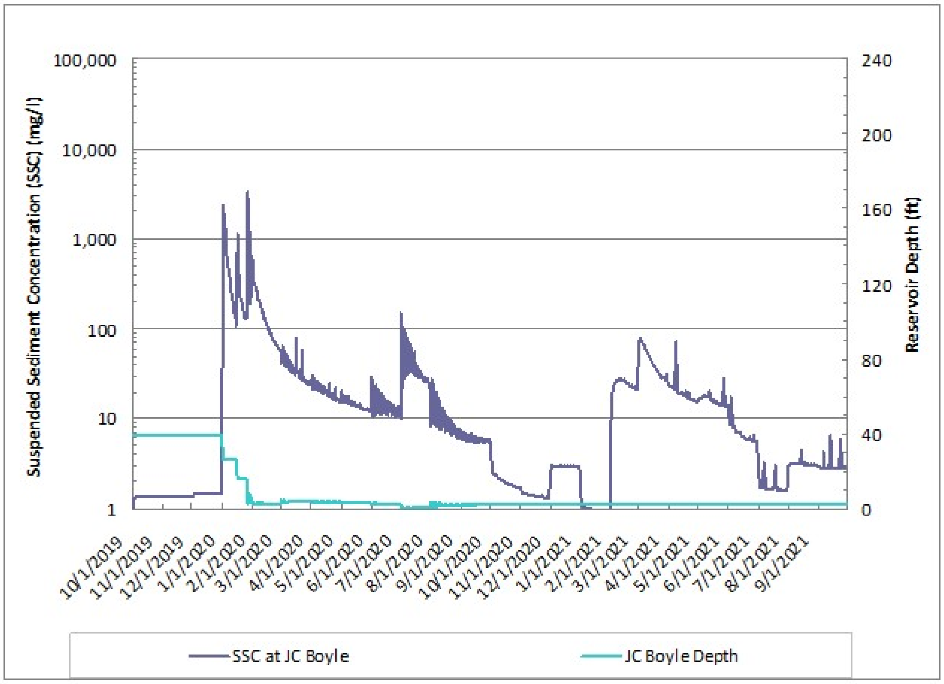

Figure 3.2-11. Suspended Sediment Concentrations Modeled at J.C. Boyle Reservoir Under the Proposed Project Assuming Typical Dry Hydrology (WY2001). Dam removal year 1 is represented by the year 2019, dam removal year 2 is represented by the year 2020, and post-dam removal year 1 is represented by the year 2021.

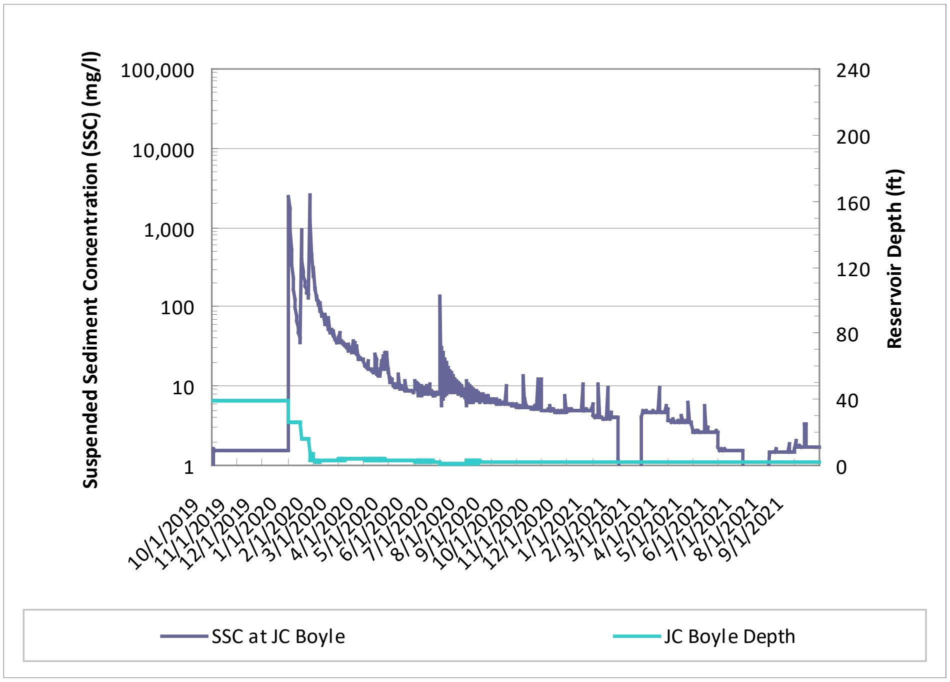

Figure 3.2-12. Suspended Sediment Concentrations Modeled at J.C. Boyle Reservoir Under the Proposed Project Assuming Median Hydrology (WY1976). Dam removal year 1 is represented by the year 2019, dam removal year 2 is represented by the year 2020, and post-dam removal year 1 is represented by the year 2021.

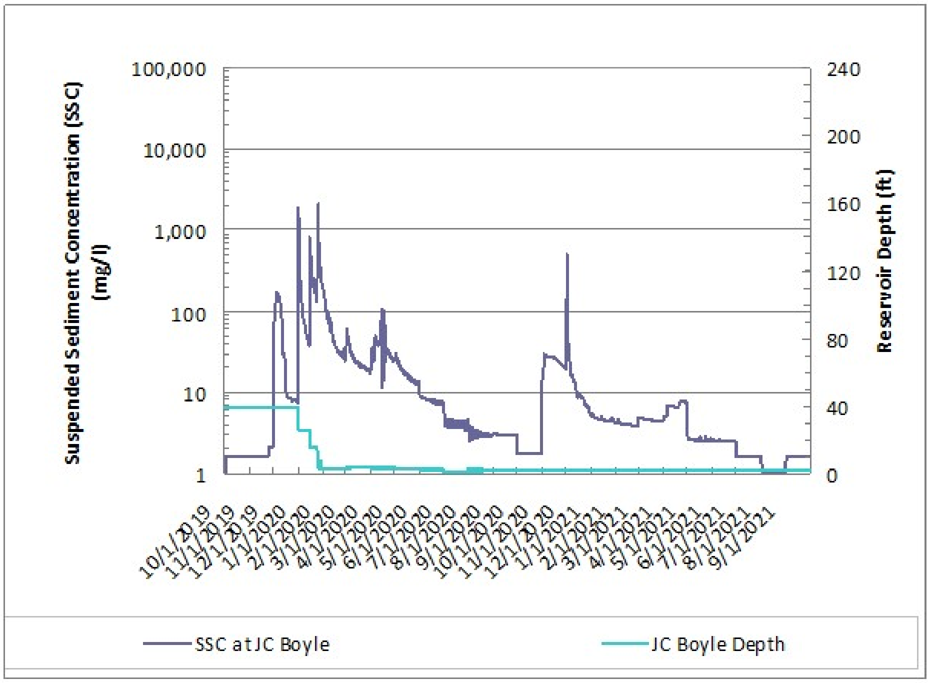

Figure 3.2-13. Suspended Sediment Concentrations Modeled at J.C. Boyle Reservoir Under the Proposed Project Assuming Typical Wet Hydrology (WY1984). Dam removal year 1 is represented by the year 2019, dam removal year 2 is represented by the year 2020, and post-dam removal year 1 is represented by the year 2021.

Modeling of sediment concentrations downstream of Copco No. 1 Reservoir during drawdown also indicates short-term sediment concentrations would be high in the California portion of the Hydroelectric Reach due to dam removal (Figure 3.2-14). Modeled SSCs downstream of Copco No. 1 Reservoir in dry, average and wet water year types peaked at approximately 7,000–8,000 mg/L within one to two months of initiation of reservoir drawdown; SSCs then decrease to generally less than 1,000 mg/L by approximately one and a half to two and a half months after initiation of reservoir drawdown. During this period, the modeled SSCs would exceed the suspended sediments potential short-term significance threshold of 100 mg/L over a continuous two-week period. Predicted spikes in SSC after one to two months of reservoir drawdown correspond to increases in Klamath River flow through the Hydroelectric Reach due to spring storm events (Figure 3.2-14).

Similar to conditions immediately downstream of J.C. Boyle, higher maximum drawdown rate under the Proposed Project (i.e., 5 feet per day) would not alter the short-term impact determination since the higher drawdown rate under the Proposed Project would be unlikely to reduce the duration of SSCs above 100 mg/L to less than two consecutive weeks under all water years types. Peak SSCs would be expected to double from approximately 7,000–8,000 mg/L under modeled conditions to approximately 14,000–16,000 mg/L under the higher drawdown rate in the Proposed Project, based on a previous analysis how suspended sediments vary under different drawdown rates in Lower Klamath Project reservoirs (Stillwater Sciences 2008). The duration of modeled SSCs greater than 100 mg/L downstream of Copco No. 1 likely would decrease under the Proposed Project with a higher drawdown rate, but the overall all duration of SSCs greater than 100 mg/L would likely occur for two consecutive weeks or more. SSCs after drawdown would potentially decrease to less than 10 mg/L more rapidly under the Proposed Project than estimated by the modeled SSCs. Thus, the short-term impact, which is based on an analysis of modeled SSCs downstream of Copco No. 1 Dam, would remain the same under the higher drawdown rate in the Proposed Project since SSCs is expected to exceed 100 mg/L for two consecutive weeks regardless of the drawdown rate.

Sediment jetting is anticipated to also increase the magnitude of modeled SSCs downstream of Copco No. 1 during drawdown (USBR 2012), but it also would not alter the overall impact of suspended sediment in the Klamath River downstream of Copco No. 1 Dam during drawdown since the increase in SSCs due to sediment jetting would primarily occur during peak SSCs and sediment jetting would not increase the duration of SSCs greater than 100 mg/L by only mobilizing more sediment during the drawdown period. Klamath River flows during drawdown at Copco No. 1 Dam range from approximately 800 cfs in a Dry water year to 13,600 cfs in a Wet water year (see Appendix B: *Definite Plan – Section 4.6*). Assuming a sediment jetting flow of approximately 10 to 30 cfs (similar to sediment jetting flows used on the Mill Pond Dam removal project, Washington Department of Ecology [2016]). SSCs in sediment jetting flows would vary depending on the pressure of the water jet, the angle of the water jet, and the cohesiveness of the reservoir deposited sediments, but SSCs in sediment jetting flows would likely range from less than 1,000 mg/L to approximately 100,000 mg/L.

SSCs in the Klamath River downstream of Copco No. 1 during drawdown with sediment jetting compared to modeled SSCs without sediment jetting are estimated to typically increase by approximately 350 mg/L to 1,400 mg/L, but SSCs would potentially increase up to approximately 2,200 mg/L compared to modeled SSCs in the Klamath River during drawdown without sediment jetting. This projected increase in SSC is based on the estimated range of sediment volume to be transported by sediment jetting, the duration of drawdown when sediment jetting would occur, and the modeled flow and SSCs for the Klamath River and the estimated flow and SSCs for sediment jetting. The typical increase in SSCs would be the expected increase under the range of typical drawdown flows under all water year types, while the maximum increase in SSCs would only be likely to occur under Klamath River minimum flows during a dry water year. Additionally, the maximum increase in SSCs in the Klamath River downstream of Copco No. 1 is a conservative estimate since it assumes sediment jetting would mobilize all the sediment in the areas undergoing jetting in the approximately three-month drawdown period. In actuality, drawdown flows would mobilize a portion of that sediment, so the actual maximum increase in SSCs downstream of Copco No. 1 would likely be less than 2,200 mg/L.

While sediment jetting would increase the magnitude of SSCs during drawdown, most of the variations in the modeled SSCs during sediment jetting would be within the range of modeled SSCs and the increase in the magnitude would not extend beyond the drawdown period since sediment jetting would only occur during drawdown. Peak SSCs during drawdown under sediment jetting would potentially increase above the range of modeled SSCs with the maximum SSCs downstream of Copco No. 1 potentially increasing from approximately 14,000–16,000 mg/L under the higher maximum drawdown flows (i.e., 5 feet per day) to approximately 16,200–18,200 mg/L under the higher maximum drawdown flows with sediment jetting. The SSCs under drawdown flows with or without sediment jetting would exceed the suspended sediments potential short-term significance criteria of 100 mg/L over a continuous two-week period. While the magnitude of SSCs would increase during drawdown with sediment jetting, the magnitude of SSCs would potentially decrease after drawdown is complete since sediment jetting would mobilize more sediment than anticipated under drawdown flows alone. Within the general uncertainty of the modeled SSCs and estimates of SSCs with sediment jetting (see Table 3.2-12), the SSCs in the Klamath River downstream of Copco No. 1 with sediment jetting would be similar to or less than the modeled SSCs without sediment jetting after drawdown ends in March.

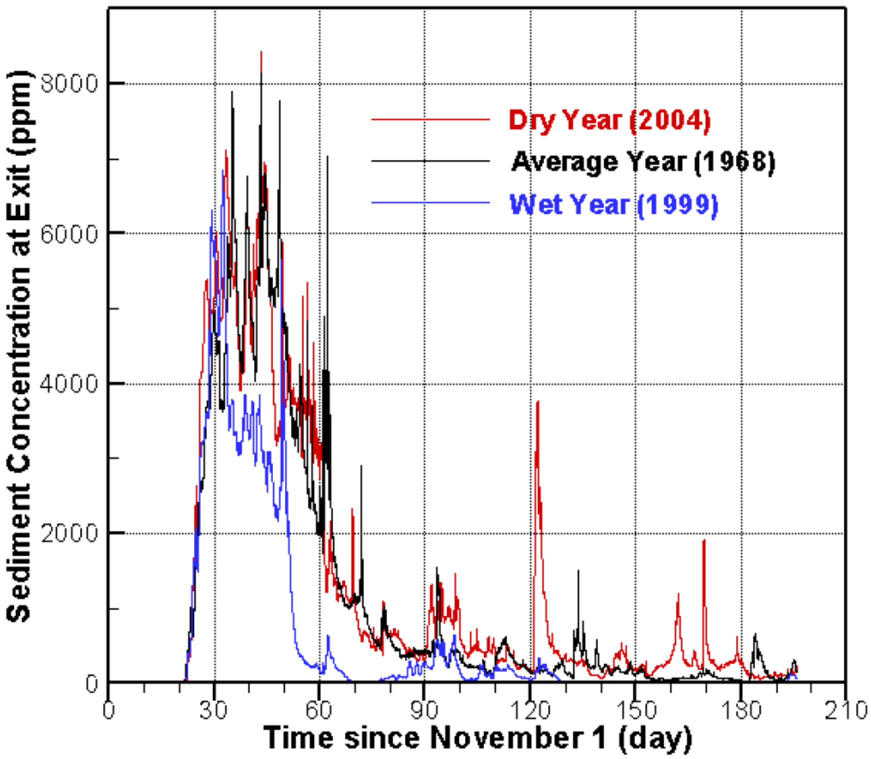

Figure 3.2-14. Sediment Concentration Downstream of Copco No. 1 Reservoir During Drawdown Using SRH-2D v3 Under Three Hydrological Scenarios. Drawdown began on November 15 and continued for six months. Source: USBR 2012.

Note that the shift in the Proposed Project Copco No. 2 drawdown timing from January 1 (Appendix B: *Detailed Plan*) to May 1 (Appendix B: *Definite Plan*) would not change the anticipated magnitude or timing of significant impacts due to elevated SSCs in the Hydroelectric Reach during dam removal year 2. SSCs associated with Copco No. 2 were not explicitly considered in the SRH-1D model, since 1) construction of Copco No. 2 dam was completed seven years after the substantially larger, upstream Copco No. 1 dam was completed, where the larger dam effectively cut off the source of sediments that would have been transported into Copco No. 2 Reservoir and potentially stored over time, and 2) Copco No. 2 Reservoir storage volume (70 ac-ft) is negligible compared with that of the upstream Copco No.1 (33,724 ac-ft) and J.C. Boyle (2,267 ac-ft) reservoirs, such that even if sediment deposits were to occur in Copco No. 2 Reservoir, either historically or during the Proposed Project drawdown of the upstream Copco No. 1 and J.C. Boyle reservoirs, the smaller Copco No. 2 Reservoir would not meaningfully increase downstream SSCs beyond currently predicted values for the period five to seven months following drawdown (May−July). Short-term increases in SSCs from removal of Iron Gate Dam are discussed for the Middle and Lower Klamath River (see below), since sediment releases from Iron Gate Reservoir would primarily impact the Klamath River downstream of the Hydroelectric Reach.

After reservoir drawdown, a significant amount of sediment is expected to remain within the reservoir footprints. Reservoir sediment field sampling and laboratory testing in 2012 (USBR 2012) and 2018 (Appendix B: *Definite Plan – Appendix H*) indicates that sediments remaining in the reservoir footprint would strengthen (i.e., harden) as they dry out, but wetting and drying cycles of unvegetated reservoir sediment would cause the sediment to produce erodible fine particles and aggregates. There is the potential for unvegetated sediments to cause significant short-term or long-term elevated SSCs during fall rain events if not stabilized with vegetation, especially from Iron Gate Reservoir where the highest levels of fine sediment and particles were produced in response to the laboratory wetting and drying cycles. These results are consistent with suspended sediment modeling results (USBR 2012) indicating that SSCs can periodically increase during post-dam removal year 1 due to storm conditions.

The Proposed Project includes revegetation of reservoir sediments remaining on the floodplain and the surrounding slopes after drawdown to stabilize the sediments and reduce the potential for short-term and long-term elevated SSCs. Stabilization of sediments through planting is expected to be effective since laboratory revegetation "grow tests" showed vegetation stabilized sediments from Copco No. 1 (Appendix B: *Definite Plan – Appendix H, Section 8.1.1 Reservoir Sediment Characteristics*). The Proposed Project Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*; see also Section 2.7.4 *Restoration Within the Reservoir Footprint*) includes activities to promote revegetation and sediment stabilization such as sediment preparation and amendment, irrigation, aerial seeding using pioneer seed mixes, planting of pole cuttings, acorns, and container plants, and adaptively re-seeding/re-planting areas that do not sufficiently establish following initial restoration activities.

During the drawdown period in January to March of dam removal year 2, aerial seeding would occur as the reservoir water level drops before the exposed reservoir sediments dry and form a surface crust. Pioneer seed mixes would contain a variety of riparian and upland common native species and possibly a small amount of sterile non-native species to enhance the initial erosion protection. The species included in the seed mix typically germinate early in the spring (March−April) and their germination would be sustained by dispersal over moist reservoir sediments during drawdown in the winter and early spring (January−March). Reservoir footprint areas that are re-inundated by larger storm events would be re-seeded after the water level recedes.

Aerial seeding would not result in any further disturbance of soil on the exposed reservoir terraces in the Hydroelectric Reach and the establishment of vegetation on the terraces would potentially reduce erosion of fine sediments. In areas not accessible by ground equipment because of rough terrain, steep slopes, and sediment instability, and as a potential alternative to aerial seeding, the Proposed Project may hydroseed from a barge located in Proposed Project reservoirs.[52]

During the dam removal period from March to December of dam removal year 2, additional revegetation efforts would be undertaken, including seed plantings, monitoring of plant growth and vegetation cover, re-seeding of areas with poor growth, continued

[52] If it occurs, barge hydroseeding would be unlikely to exacerbate erosion impacts beyond the impacts of reservoir drawdown itself. Reservoir drawdown would extend potential wave-induced erosion impacts below the existing normal fluctuation zone with brief (i.e., hours to a day) periods of interaction with the "new shoreline" as drawdown continues. Barges tend to generate low wave heights due to their wide, flat bottoms and low operating speeds and any concentrated additional wave-induced erosion from barge hydroseeding would be limited to a shorter duration (i.e., over several hours within a single day) than that of wind-action on the slowly downward-moving reservoir surface.

installation of pole cuttings, and maintenance of existing and previously planted vegetation. Woody riparian species would be planted in the riparian areas to increase natural bank stability along with providing ecological benefits for fish. Irrigation systems would be installed along key segments of the river banks to expedite riparian bank zone development. Several repeated seedings and/or plantings would be adaptively performed as necessary during the first two years following reservoir drawdown in order to increase native vegetation coverage in underperforming areas.

In addition to planting and revegetation activities, the Proposed Project also includes creation of physical features or conditions (e.g., grading, swales, wetlands, floodplain roughness features, and river bank roughness features) that would stabilize remaining reservoir sediments deposits and reduce the potential for short-term and long-term increases in SSCs (Appendix B: *Definite Plan – Appendix H, Section 5.5 Description of Restoration Actions*). As detailed in the Proposed Project Reservoir Area Management Plan (see Section 2.7 *Proposed Project*), grading would only occur for reservoir deposited sediments between January and April of the drawdown year, with no grading below the historical ground surface prior to dam construction. In the newly exposed reservoir footprints under the Proposed Project, swales, wetlands, floodplain roughness features (e.g., partially buried brush or wood), and bank roughness features (e.g., large woody habitat) would be constructed to stabilize the remaining reservoir sediments, reduce velocities along the floodplain and riverbank that would increase suspended sediments, and reduce unnatural erosion that would potentially degrade water quality (i.e., by elevating suspended sediments) while still maintaining natural river processes. Creation of the other physical features and conditions are likely to be effective sediment stabilization and suspended sediment reduction methods because they slow down stormwater runoff, floodplain flows, and river flows along the river banks that would potentially cause elevated suspended sediments, allow for suspended sediments to settle out prior to entering tributaries or Klamath River, and provide storage for sediment that may settle (CSQA 2003; Stubblefield et al 2006; Knox et al. 2008). The State Water Board's draft water quality certification includes Condition 13, which requires submission of a Restoration Plan that incorporates the major elements discussed above regarding revegetation, and also other activities that can reduce sediment loading to the Klamath River over the long term, including grading, swales, and wetland construction.

Although revegetation of the reservoir sediment deposits would stabilize the sediment and reduce the potential for short-term and long-term elevated suspended sediment concentrations in the Hydroelectric Reach after vegetation begins to grow and establish (i.e., summer drawdown year 2 to post-dam removal year 1) and other restoration plan elements such as grading, swales, and wetland construction would reduce both short-term and long-term sediment loading, there still is the potential for short-term increases in SSCs in the months following reservoir drawdown prior to the establishment of vegetation to stabilize sediments. Laboratory tests of reservoir sediments determined repeated wetting (e.g., from rainfall) and drying of reservoir sediment deposits under conditions similar to those expected to occur in the reservoir footprints after drawdown would form easily erodible fine particles, so unvegetated sediments would potentially produce elevated SSCs during rainfall events (Appendix B: *Definite Plan – Appendix H, Section 8.1.1 Reservoir Sediment Characteristics*). Short-term potential increases in SSCs from rainfall on reservoirs sediments without established vegetation alone would be unlikely to result in SSCs greater than 100 mg/L for a continuous two-week period. However, the short-term potential increases in SSCs due to rainfall on reservoir sediments without established vegetation combined with the short-term increases in

SSCs due to the release of reservoir sediments from behind the Lower Klamath Project dams would potentially result in SSCs greater than 100 mg/L for a longer duration than would occur due to only the short-term increases in SSCs from the release of reservoirs sediment from behind Lower Klamath Project dams, thus the short-term potential increases in SSCs from rainfall on reservoir sediments without established vegetation would have a significant adverse impact to salmonids and cause a substantial change in water quality (i.e., suspended sediment) that would result in a failure to maintain existing beneficial uses at the levels currently supported, resulting in a short-term significant impact to suspended sediments in the Hydroelectric Reach.

Physical removal of reservoir bottom sediments prior to drawdown is not feasible because dredging would remove only a maximum of 43 percent of erodible reservoir sediment, would only provide a marginal benefit to fish during drawdown with 57 percent of erodible sediment remaining, and would have a large environmental impact on terrestrial resources and possibly cultural resources (Lynch 2011). Slower drawdown to potentially mobilize less sediment or altering the timing of drawdown to lessen the potential of precipitation after drawdown and before plantings have stabilized sediments have also been suggested as potential approaches to reduce sediment impacts. However, both of these alterations would increase the time elevated SSCs would occur during sensitive fish life-stages, resulting in greater adverse impacts to designated beneficial uses and/or fish (see Section 4.1.1.4 *Elimination of Potential Alternatives that Would Not Avoid or Substantially Lessen Significant Environmental Effects of the Proposed Project*). Thus, the short-term significant impact of increased SSCs due to dam removal in the Hydroelectric Reach cannot be avoided or substantially decreased through feasible mitigation.

With respect to the potential for long-term increases in SSCs in the Hydroelectric Reach due to the Proposed Project, modeling indicates SSCs return to modeled background levels (i.e., existing conditions) under all water year types during post-dam removal year 1 (USBR 2012). Potential long-term increases in SSCs due to production of erodible sediments from the remaining reservoir sediment deposits would likely be almost to completely offset by long-term decreases in SSCs due to revegetation of remaining reservoirs sediment deposits. To address uncertainties associated with revegetation and sediment stabilization activities (e.g., variations in plant germination success, plant growth rate, seasonal precipitation, reservoir sediment changes), monitoring and adaptive management of these revegetation and sediment stabilization activities would occur under the Proposed Project (Appendix B: *Definite Plan – Appendix H, Section 6 Monitoring and Adaptive Management*). Monitoring of the remaining reservoir sediment deposits would be conducted yearly for post-dam removal year 1 to 5 to evaluate the effectiveness of these activities using yearly visual inspection (aerial and ground photos) as well as yearly Light Detection and Ranging (LiDAR) flights of the reservoir area to estimate changes in the remaining reservoir sediment deposits. Adaptive management under the Proposed Project would utilize the monitoring data, threshold metrics for evaluating whether actions would be needed, and potential actions to be undertaken if threshold metrics are not achieved. For example, aerial and ground photos would be used to evaluate the percent relative vegetation cover with additional vegetation seeding or planting occurring if vegetation cover does not meet annually specified average percent relative vegetation cover targets. Overall, monitoring and adaptive management would likely result in revegetation that stabilizes remaining reservoirs sediments, so long-term potential increases in SSCs due to production of erodible sediments from the remaining would be unlikely to result in elevated SSCs in the Klamath River and there would be a long-term less than significant impact on SSCs in the Hydroelectric Reach.

Slowly, over several decades, high winter flows in the Hydroelectric Reach are expected to gradually widen the floodplain in the reservoir footprints through natural fluvial processes (USBR 2012). Erosion associated with the widening of the floodplain is not anticipated to result in SSCs above modeled background levels (i.e., existing conditions) due to the anticipated slow pace of this change (i.e., decades), so long-term erosion and associated SSCs from widening of the floodplain would not cause an exceedance of water quality standards related to suspended sediments or cause changes in suspended sediments that would result in a failure to maintain existing designated beneficial uses at the levels currently supported. Therefore, there would be no significant impact to the Hydroelectric Reach in the long term due to the release of sediments currently trapped behind the Lower Klamath Project dams since SSCs are expected to resume modeled background levels (i.e., existing conditions) in the long term, regardless of the water year type present during the dam removal.

Middle and Lower Klamath River and Klamath River Estuary

Sediment transport modeling of the impacts of dam removal on suspended sediment also indicates high short-term loads immediately downstream from Iron Gate Dam under the Proposed Project (Stillwater Sciences 2008; USBR 2012, 2016). As described above, the Proposed Project involves drawdown for Copco No. 1 Reservoir beginning on November 1 and drawdown for J.C. Boyle and Iron Gate reservoirs beginning on January 1 (USBR 2012), which allows maximum SSCs to occur during winter months when flows and SSCs are naturally high in the mainstem river (see Appendix C, Figure C-15). Drawdown of Copco No. 2 occurs on May 1 (Appendix B: *Definite Plan*) under the Proposed Project, but Copco No. 2 Reservoir would not meaningfully increase downstream SSCs due to lack of sediment storage under current conditions and its small size relative to the upstream reservoirs, as discussed for the Hydroelectric Reach above.

Suspended sediment model predictions immediately downstream of Iron Gate Dam due to the release of sediments within J.C. Boyle, Copco No. 1, and Iron Gate reservoirs under the Proposed Project are presented in Figure 3.2-15 through Figure 3.2-17 for three water year types[53] (dry, median, wet) considered as part of the Klamath Dam Removal Secretarial Determination process. As discussed in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, model predictions made using hydrology assumptions adopted for the Klamath Dam Removal Secretarial Determination are still appropriate for assessing Proposed Project impacts since the NMFS 2013 Biological Opinion mandatory flows are encompassed within the modeled range of flows (USBR 2016). Model predictions are discussed below and summarized in Table 3.2-13.

[53] SSCs downstream of Iron Gate Dam cannot be directly compared with the SSCs modeled downstream of Copco No. 1 Reservoir. SSC modeling downstream of Copco No. 1 Reservoir use different years to represent the three water year types than the SSC modeling downstream of J.C. Boyle Dam or Iron Gate Dam, so the specific hydrologic conditions (i.e., timing and magnitude of flow changes from storms) and resulting SSCs are different.

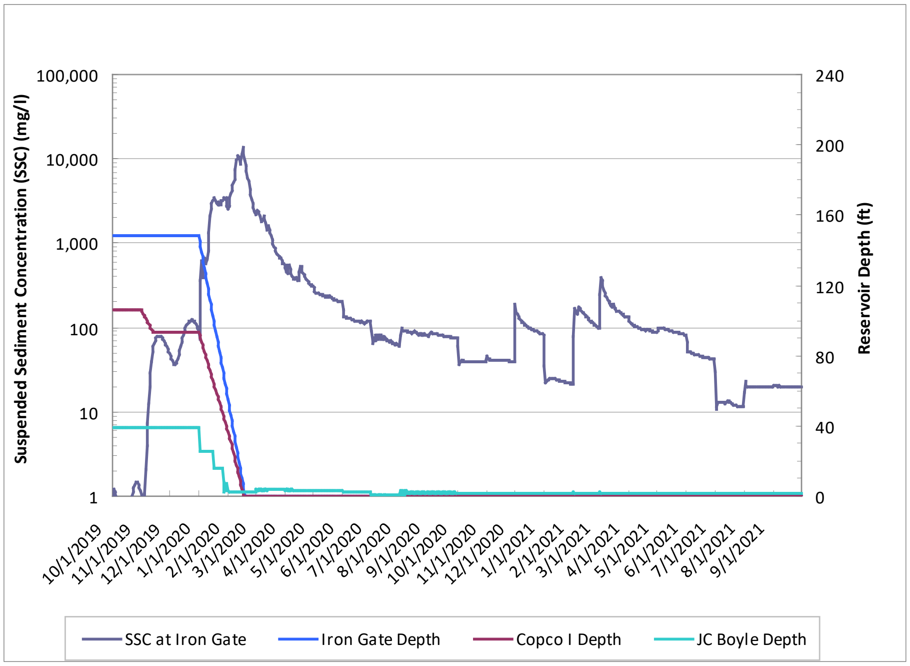

Figure 3.2-15. SSCs Modeled Downstream from Iron Gate Dam Under the Proposed Project Assuming Typical Dry Hydrology (WY2001). Dam removal year 1 is represented by the year 2019, dam removal year 2 is represented by the year 2020, and post-dam removal year 1 is represented by the year 2021.

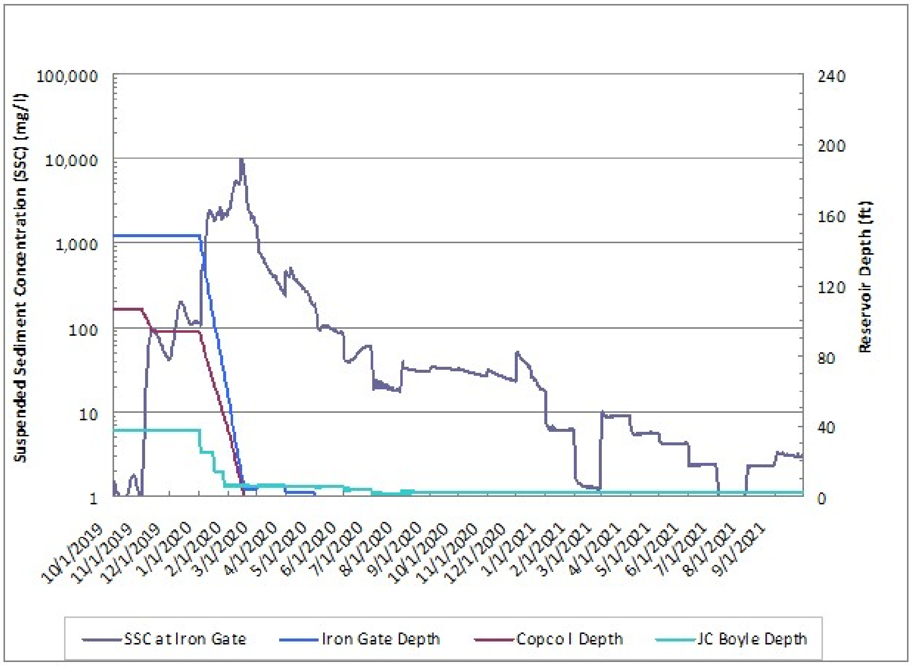

Figure 3.2-16. SSCs Modeled Downstream from Iron Gate Dam Under the Proposed Project Assuming Median Hydrology (WY1976). Dam removal year 1 is represented by the year 2019, dam removal year 2 is represented by the year 2020, and post-dam removal year 1 is represented by the year 2021.

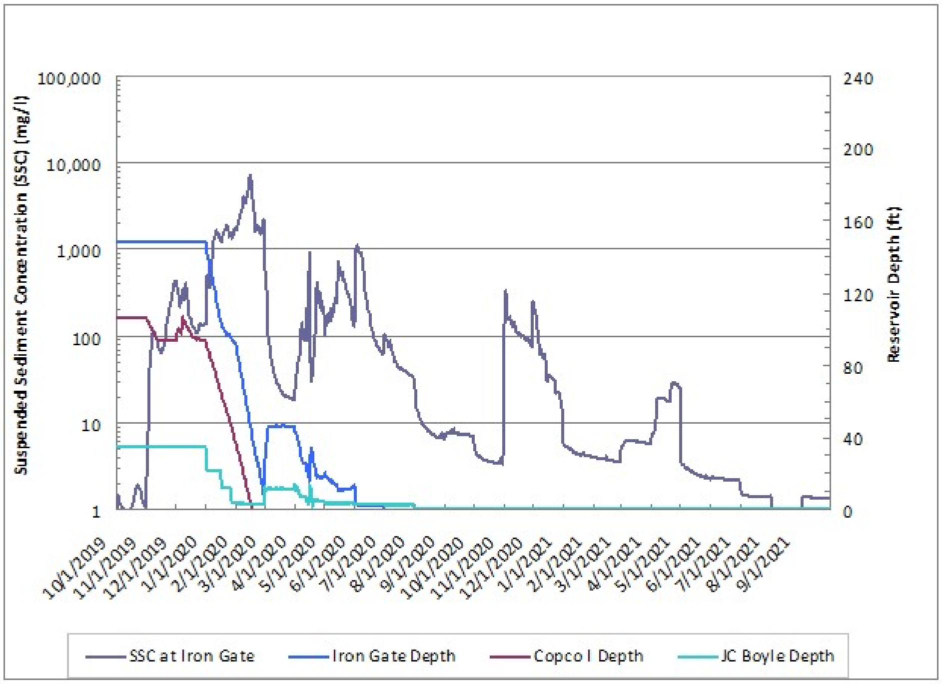

Figure 3.2-17. SSCs Modeled Downstream from Iron Gate Dam Under the Proposed Project Assuming Typical Wet Hydrology (WY1984). Dam removal year 1 is represented by the year 2019, dam removal year 2 is represented by the year 2020, and post-dam removal year 1 is represented by the year 2021.

Table 3.2-13. Summary of Model Predictions for SSCs in the Klamath River Downstream from Iron Gate Dam for the Proposed Project During Dam Removal Years 1 and 2

Water Year Type	Peak SSC[1] (mg/L)	SSC-1,000 mg/L		SSC-100 mg/L		SSC-30 mg/L	
		Duration (Months)	Time Period[2]	Duration (Months)	Time Period[2]	Duration (Months)	Time Period[2]
Dry (WY2001)	13,600	3	January–March	6	January–June	10	January–October
Median (WY1976)	9,900	2	January–February	5	January–May	6	January–June
Wet (WY1984)	7,100	2	January–February and April–July	7	November–February and April–July	9	November–July

[1] Actual peak concentrations may greater than predicted peak concentrations due to the proposed 5 feet per day maximum drawdown rate for the Proposed Project (see also Section 3.2.4.2 *Suspended Sediments*).
[2] All months shown are during dam removal year 2.

For typical dry year (WY2001) hydrologic conditions, modeled SSCs in the Klamath River immediately downstream from Iron Gate Dam experience a relatively small increase to near 100 mg/L in mid-November of dam removal year 1 as Copco No. 1 undergoes early drawdown at a maximum rate of two feet per day. A second, relatively large increase (greater than 1,000 mg/L) would occur in early January of dam removal year 2 when Iron Gate and J.C. Boyle begin drawdown at rates of two to five feet per day and Copco No. 1 enters a second phase of drawdown, also at a rate of two to 5 feet per day. Concentrations remain very high (greater than 1,000 mg/L) for approximately three months from January through April of dam removal year 2 (see Figure 3.2-11), with peak values exceeding 10,000 mg/L for a short period (four to five days) in mid-February of dam removal year 2. SSCs generally return to less than 100 mg/L by July, and to concentrations near 30 mg/L by October of dam removal year 2. Predicted SSCs increase again to levels between 200–400 mg/L during winter and spring of post-dam removal year 1 (2021) due to flushing of sediments that were not removed during the first year following drawdown.

Model predictions for median year (WY1976) hydrologic conditions follow a pattern similar to that of a typical dry year (WY2001), with a relatively small increase in SSCs (to near 200 mg/L) in mid-December of dam removal year 1, and a large increase (greater than 1,000 mg/L) again in early January of dam removal year 2. Peak SSCs downstream from Iron Gate Dam are predicted to be somewhat lower for the median year condition, reaching levels just under 10,000 mg/L. Relative to the typical dry year, the lower median year peak SSCs are a result of greater flows flushing nearly the same volume of sediment out of the reservoir and downstream. Peak concentrations also occur in mid-February of dam removal year 2 for the median year hydrologic condition (see Figure 3.2-16). Predicted SSCs downstream from Iron Gate Dam remain very high (greater than 1,000 mg/L) for approximately two months following the beginning of drawdown in Iron Gate and Copco No. 1 reservoirs, from January through February of dam removal year 2. There is a slightly earlier return to SSCs less than 100 mg/L for the median year (WY1976), with concentrations decreasing by May of dam removal year 2 due to the higher Klamath River flow under a median year. Modeled SSCs decrease to less than 30 mg/L by June of dam removal year 2 and fluctuate between 10 mg/L and 100 mg/L through the remainder of dam removal year 2. Modeled SSCs do not exceed 100 mg/L for two consecutive weeks after June of dam removal year 2 since SSCs remain below 100 mg/L after June of dam removal year 2. The Proposed Project is not expected to increase SSCs above 100 mg/L for the typical median water year condition in post-dam removal year 1 (2021) with modeled SSCs always less than 100 mg/L, but SSCs may vary between approximately 1 and 100 mg/L in that year due to erosion of sediment deposits remaining in the reservoir footprint area. Thus, model results indicate SSCs would remain below the 100 mg/L for two consecutive weeks threshold of significance for SSCs after June of dam removal year 2.

Model predictions for typical wet year (WY1984) hydrologic conditions indicate a higher initial pulse of fine sediments following the Copco No. 1 Reservoir drawdown in early to mid-December of dam removal year 1, with concentrations at or near 400 mg/L. Model predictions indicate that for typical wet year conditions, the outlet capacity at Copco No. 1 Dam is exceeded during the same timeframe and the reservoir fills slightly (see Figure 3.2-17). Very high (greater than 1,000 mg/L) SSCs are experienced for approximately two months following the beginning of drawdown in the reservoirs, from January through February of dam removal year 2 (see Figure 3.2-17). SSCs reach approximately 7,100 mg/L, with peak values occurring in mid-February of dam removal year 2. SSCs generally return to less than 100 mg/L during the month of March, but then secondary peaks (approximately 1,000 mg/L) in SSCs occur in mid-April and June of dam removal year 2 for wet year (WY1984) hydrologic conditions. After the secondary peaks, SCCs again returns to less than 100 mg/L by the beginning of July in dam removal year 2 and continues to decrease until SSCs are less than 30 mg/L by the end of July in dam removal year 2. Predicted SSCs increase again to levels between 200–400 mg/L during the end of dam removal year 2 (i.e., November) and the beginning of post-dam removal year 1 (2021) (i.e., January) before decreasing below 30 mg/L by February as high winter flows in the Klamath River flush sediments downstream that were not removed during drawdown. A secondary increase in SSCs to approximately 30 mg/L occurs around April to May in post-dam removal year 1 from a storm event, but rapidly decreases once Klamath River flows decrease.

As discussed for the *Hydroelectric Reach*, the shift in the Proposed Project Copco No. 2 drawdown timing from January 1 (Appendix B: *Detailed Plan*) to May 1 (Appendix B: *Definite Plan*) would not change the anticipated magnitude or timing of significant impacts due to elevated SSCs in the Hydroelectric Reach during dam removal year 2.

For all three water year types, predicted SSCs in the Middle and Lower Klamath River decrease to 60 to 70 percent of the Iron Gate Dam value by Seiad Valley (RM 132.7) and to 40 percent of the Iron Gate Dam value by about RM 58.9, downstream from Orleans (USBR 2012). SSCs in the Middle and Lower Klamath River and the Klamath River Estuary are predicted to resume modeled background levels (i.e., existing conditions) by the end of post-dam removal year 1 under all water year types, especially with revegetation of the reservoir sediments immediately following dam removal which would stabilize the sediment from erosion due to rainfall and reduce SSCs after drawdown compared to the modeled SSCs (USBR 2012). Modeled SSCs did not consider reductions in SSCs due to revegetation activities.

Modeled SSCs across the three water year types would have peak values of approximately 7,000 to 14,000 mg/L immediately downstream of Iron Gate Dam and these peak values would occur within two to three months of reservoir drawdown. Model results indicate SSCs in excess of 1,000 mg/L would occur on a timescale of weeks to months (see Table 3.2-13), as compared to SSCs greater than 1,000 mg/L that can occur during winter storm events on a timescale of days to weeks under existing conditions in the Klamath River downstream from Iron Gate Dam (see Appendix C, Section C.2.2.2 *[Suspended Sediments] Salmon River to Klamath River Estuary*). Predicted SSCs would remain greater than or equal to 100 mg/L for five to seven months following drawdown, and concentrations would remain greater than or equal to 30 mg/L for six to 10 months following drawdown (Table 3.2-13), as compared to suspended sediments downstream of Iron Gate Dam under existing conditions typically ranging from approximately 1 to 20 mg/L between May and December with only occasional peaks of approximately 56 to 437 mg/L (see Appendix C, Section C.2.2.2 *[Suspended Sediments] Salmon River to Klamath River Estuary*).

Similar to conditions downstream of J.C. Boyle and Copco No. 1, the higher maximum drawdown rate under the Proposed Project (i.e., 5 feet per day) than under modeled conditions is expected to increase peak SSCs and decrease the duration of elevated SSCs compared to modeled SSCs (see Section 3.2.4.2 *Suspended Sediments*), but variations in modeled SSCs due to a higher drawdown rate would be unlikely to reduce the duration of SSCs above 100 mg/L to less than two consecutive weeks under all water years types. Peak SSCs would be expected to double from approximately 7,000 to 14,000 mg/L immediately downstream of Iron Gate Dam under modeled conditions to approximately 14,000–28,000 mg/L under the higher drawdown rate in the Proposed Project, based on a previous analysis how suspended sediments vary under different drawdown rates in Lower Klamath Project reservoirs (Stillwater Sciences 2008). The higher drawdown rate would also potentially decrease the duration of elevated suspended sediments by approximately one to two weeks since suspended sediments decrease more rapidly after peak SSCs occur due to the increased transport of reservoir deposits at the higher drawdown rate (Stillwater Sciences 2008). While potential decreases in the duration of elevated suspended sediments under a higher drawdown rate would be unlikely to significantly alter the duration of SSCs greater than 1,000 mg/L (i.e., peak SSCs) downstream of Iron Gate, the duration of modeled SSCs downstream of Iron Gate Dam greater than 100 mg/L would likely occur as SSCs decrease more rapidly following a higher drawdown rate. Modeled SSCs downstream of Iron Gate Dam were greater than 1,000 mg/L for two to three weeks and greater than 100 mg/L for five to seven weeks (Table 3.2-13), so SSCs still would likely be greater than 100 mg/L for at least three consecutive weeks under the higher drawdown rate in the Proposed Project. SSCs after drawdown would potentially decrease to less than 10 mg/L more rapidly under the Proposed Project than estimated by the modeled SSCs due to the increased transport of reservoir deposits at the higher drawdown rate. Thus, overall, the short-term impact based on an analysis of modeled SSCs downstream of Copco No. 1 would remain the same under the higher drawdown rate in the Proposed Project since SSCs is expected to exceed 100 mg/L for two consecutive weeks regardless of the drawdown rate.

Similar to Copco No. 1 Reservoir, sediment jetting within the Iron Gate reservoir footprint is anticipated to increase the magnitude of modeled SSCs downstream of Iron Gate during drawdown, but it would not alter the overall impact of suspended sediment in the Klamath River downstream of Iron Gate Dam during drawdown since the increase in SSCs due to sediment jetting would primarily occur during peak SSCs and sediment jetting would not increase the duration of SSCs greater than 100 mg/L by mobilizing more sediment only during drawdown. Klamath River flows during drawdown at Iron Gate Dam range from approximately 1,000 cfs in a Dry water year to 24,500 cfs in a Wet water year (see Appendix B: *Definite Plan – Section 4.6*). A typical sediment jetting flow would be approximately 10 to 30 cfs with SSCs the flow likely ranging from less than 1,000 mg/L to approximately 100,000 mg/L, assuming the Proposed Project operations would be similar to sediment jetting flows used on the Mill Pond Dam removal project, Washington Department of Ecology [2016]).

Sediment jetting in the Iron Gate Reservoir footprint during drawdown is estimated to typically increase SSCs by approximately 270 mg/L to 1,200 mg/L compared to modeled SSCs without sediment jetting, but SSCs would potentially increase up to approximately 1,700 mg/L based on the estimated sediment volume to transport by sediment jetting, the duration of drawdown, and the flow and SSCs for the Klamath River and the sediment jetting. The typical increase in SSCs would be the expected increase under the range of typical drawdown flows under all water year types, while the maximum increase in SSCs would only be likely to occur under Klamath River minimum flows during a dry water year. Additionally, the maximum increase in SSCs from sediment jetting within the Iron Gate Reservoir footprint is a conservative estimate, since it assumes sediment jetting would mobilize all the sediment in the areas undergoing jetting. Drawdown flows would mobilize a portion of that sediment, so the actual maximum increase in SSCs would likely be less than 1,700 mg/L. SSCs in the Klamath River downstream of Iron Gate Dam would also be increased by sediment jetting activities in the Copco No. 1 reservoir footprint, so the overall SSCs increase in the Klamath River downstream of Iron Gate Dam from sediment jetting in both reservoirs during drawdown would typically range from 620 mg/L to 2,600 mg/L compared to modeled SSCs without sediment jetting, reaching up to approximately 3,900 mg/L if the maximum increase in SSCs from sediment jetting in Copco No. 1 and Iron Gate occurred simultaneously.

Sediment jetting would increase the magnitude of SSCs during drawdown, but most of the variations in the modeled SSCs during sediment jetting would be within the range of modeled SSCs and the increase in the magnitude would not extend beyond the drawdown period since sediment jetting would only occur during drawdown. Peak SSCs during drawdown under sediment jetting would potentially increase above the range of SSCs anticipated with the higher drawdown rate (i.e., 5 feet per day) with the maximum SSCs downstream of Iron Gate Dam potentially increasing from 14,000–28,000 mg/L (under only drawdown flows at a 5 feet per day drawdown rate) to approximately 17,900–31,900 mg/L (under drawdown flows at a 5 feet per day drawdown rate with sediment jetting in both the Copco No. 1 and Iron Gate reservoir footprints). The SSCs under drawdown flows at the higher drawdown rate with or without sediment jetting would exceed the suspended sediments potential short-term significance criteria of 100 mg/L over a continuous two-week period. While the magnitude of SSCs would increase during drawdown with sediment jetting, the magnitude of SSCs would potentially decrease after drawdown is complete since sediment jetting would mobilize more sediment than anticipated under drawdown flows alone. Within the general uncertainty of the modeled SSCs and estimates of SSCs with sediment jetting (see Table 3.12-2), the SSCs in the Klamath River downstream of Iron Gate Dam with a higher drawdown rate (i.e., 5 feet per day) and sediment jetting would be similar to or less than the modeled SSCs without sediment jetting after drawdown ends in March.

Model results also indicate that tributary inflow would create dilution in the lower Klamath River that would decrease SSCs, so the SSCs at Seiad Valley (RM 132.7) would be 60 to 70 percent of the SSCs immediately downstream of Iron Gate Dam and SSCs at Orleans (approximately RM 59) would be 40 percent of the SSCs immediately downstream of Iron Gate Dam. However, modeled SSCs in the Middle and Lower Klamath River would be greater than 100 mg/L for two consecutive weeks or more during drawdown depending on the water year type (USBR 2012), thus there would be a substantial adverse impact on salmonids and beneficial uses throughout these reaches and in the Klamath River Estuary in the short term. After consideration of the changes in modeled SSCs due to a higher maximum drawdown rate (i.e., 5 feet per day) and sediment jetting, SSCs in the Middle and Lower Klamath River and the Klamath River Estuary still would likely remain greater than 100 mg/L for two consecutive weeks or more. As such, SSCs in the Middle and Lower Klamath River and Klamath River Estuary due to release of reservoir sediments under the Proposed Project would be a substantial adverse impact on water quality in the short term and also result in a substantial adverse impact to salmonids and associated designated beneficial uses. A more detailed analysis of the anticipated suspended sediment impacts on key fish species, including salmonids, in the lower river is presented in Section 3.3.5.1 *Suspended Sediment.*

Sediment release associated with the Proposed Project would cause short-term increases in suspended material (greater than 100 mg/L for two or more consecutive weeks) that would cause an exceedance of water quality standards. Additionally, sediment release associated with the Proposed Project would cause water quality changes that would result in a failure to maintain existing beneficial uses at the levels currently supported due to non-attainment of applicable Basin Plan water quality objectives for suspended material in the Middle and Lower Klamath River and the

Klamath River Estuary; and substantial water quality changes that would adversely affect the cold freshwater habitat (COLD), rare, threatened, or endangered species (RARE), and migration of aquatic organisms (MIGR) beneficial uses. Sediment release associated with the Proposed Project would also result in non-attainment of applicable Hoopa Valley Tribe and Yurok Tribe narrative suspended material, settleable material, and sediment water quality objectives applicable the portions of the Klamath River within tribal boundaries.

Consistent with conditions described above in the *Hydroelectric Reach*, the short-term significant impact of increased SSCs due to dam removal in the Middle and Lower Klamath River and the Klamath River Estuary cannot be avoided or substantially decreased through reasonably feasible mitigation.

As discussed above for the *Hydroelectric Reach*, SSCs are expected to resume modeled background (i.e., existing conditions) SSCs by the end of post-dam removal year 1 regardless of the type of hydrology (dry, normal, or wet conditions) present during the drawdown period (USBR 2012). Thus, in the long term there would be no significant impact due to elevated SSCs in the Middle and Lower Klamath River and the Estuary due to the release of sediments currently trapped behind the Lower Klamath Project dams.

Pacific Ocean Nearshore Environment

Sediment transport modeling predicted that 1.2 to 2.3 million tons of sediment (5.4 to 8.6 million cubic yards, or 36 to 57 percent of the total sediments deposited behind the dams by 2020) would be eroded from the reservoir areas upon dam removal (USBR 2012) (see also Tables 2.7-7 through 2.7-9). The range of potential erosion volumes is due to the range in potential water year types that could occur during the year of dam removal. The sediment transported by the Klamath River to the Pacific Ocean due to dam removal is expected to be less than the total amount transported in a typical wet year, but greater than that transported during a dry year. See Section 3.11.5 *[Soil, Geology, and Mineral Resources] Potential Impacts and Mitigation* and Figure 3.11-12 for further details.

The California Marine Life Protection Act (MLPA) 2008 Draft Master Plan identifies freshwater plumes as one of three prominent habitats with demonstrated importance to coastal species (California Marine Life Protection Act 2008). The California MLPA Master Plan Science Advisory Team (2011) Methods Report designates river plumes as a key habitat to be included in marine protected areas because they harbor a particular set of species or life stages, have special physical characteristics, or are used in ways that differ from other habitats. While Goal 4 of the California MPLA 2016 Final Master Plan for the North Coast specifies protection of habitats identified by the California MLPA Master Plan Science Advisory Team, the MPLA 2016 Final Master Plan does not explicitly consider freshwater plumes as one of the habitat types (CDFW 2016).

A recent USGS overview report on the sources, dispersal, and fate of fine sediment delivered to California's coastal waters (Farnsworth and Warrick 2007) found the following:

- Rivers dominate the supply of fine sediment to the California coastal waters, with an average annual flux of 34 million metric tons.

- All California coastal rivers discharge episodically, with large proportions of their annual sediment loads delivered over the course of only a few winter days.

Farnsworth and Warrick (2007) conclude that fine sediment is a natural and dynamic element of the California coastal system because of large, natural sediment sources and dynamic transport processes.

After exiting the river mouth, the high SSCs (greater than 1,000 mg/L) transported by the Lower Klamath River would form a surface plume of less dense (i.e., less salty), turbid, surface water floating on more dense, salty ocean water (Mulder and Syvitski 1995). No detailed investigations of the likely size and dynamics of the Klamath River plume have been conducted. Thus, it is not possible to predict the sediment deposition pattern and location in the nearshore environment with exactitude. However, the general dynamics and transport mechanisms of fine sediment can be surmised based upon regional oceanographic and sediment plume studies.

In northern California, plume zones are primarily north of river mouths because alongshore currents and prevailing winds are northward during periods of strong runoff (Geyer et al. 2000, Pullen and Allen 2000, Farnsworth and Warrick 2007, California MLPA Master Plan Science Advisory Team 2011). Surface plumes occurring during periods of northerly upwelling-favorable winds will thin and stretch offshore, while in the presence of southern downwelling-favorable winds the plume may hug the coastline and mix extensively (Geyer et al. 2000, Pullen and Allen 2000, Borgeld et al. 2008). River plume area, location, and dynamics are also affected by the magnitude of river discharge, SSCs, tides, the magnitude of winter storms, and regional climatic and oceanographic conditions such as El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation climate cycles (Curran et al. 2002).

During several large flood events on the geographically near Eel River in the winter of 1997 and 1998, Geyer et al. (2000) found the following: (1) flood conditions were usually accompanied by strong winds from the southern quadrant; (2) the structure of the river plume was strongly influenced by the wind-forcing conditions; (3) during periods of strong southerly (i.e., downwelling favorable) winds, the plume [in the Pacific Ocean nearshore environment] was confined inside the 164 feet isobath (sea floor contour at 164 feet below the water surface), within about 4 miles of shore; (4) occasional northerly (upwelling favorable) winds arrested the northward motion of the plume and caused it to spread across the shelf; (5) transport of the sediment plume was confined to the inner shelf (water depths less than 164 feet), during both southerly and northerly wind conditions; (6) during southerly wind periods, fine, un-aggregated sediment was rapidly transported northward to at least 18 miles from the river mouth, but flocculated sediment was deposited within 0.6 to 6 miles of the river mouth; and (7) during northerly (upwelling favorable) winds, most of the sediment fell out within three miles of the mouth, and negligible sediment was carried farther offshore (Geyer et al. 2000). The Eel River mouth is 75 miles to the south of the Klamath River mouth and thus serves as a reasonable system for comparison.

Based upon Eel River plume studies and current knowledge of northern California oceanographic patterns, the fine sediment discharged to the Pacific Ocean nearshore environment under the Proposed Project would likely be delivered to the ocean in a buoyant river plume that hugs the shoreline as it is transported northward. However, since the flushing of sediments from behind the dams will occur over a number of weeks to months (and perhaps to some degree over one to two years), the plume carrying reservoir sediments would likely be influenced by a range of meteorological and ocean conditions (e.g., storm and non-storm periods, differing storm directions). Therefore, some of the time the plume would likely be constrained to shallower nearshore waters, while at other times it would likely extend further offshore and spread more widely, before depositing along the continental shelf in the vicinity of the mouth of the Klamath River.

The narrative California marine water quality objectives (Table 3.2-6) are applied as the threshold of significance rather than the freshwater numeric SSCs threshold of significance of 100 mg/L over a continuous two-week exposure period since the Pacific Ocean nearshore environment is a marine environment and salmonids within the Pacific Ocean nearshore environment would have more of an opportunity to avoid elevated SSCs conditions compared to opportunities within the Klamath River. While elevated SSCs (10 to 100 mg/L) created in the nearshore plume would affect physical water quality characteristics specified in the Ocean Plan (e.g., visible floating particulates, natural light attenuation, the deposition rate of inert solids), the impacts would be within the range caused by historical storm events (i.e., less than that transported in a typical wet year). While the total amount of sediment delivered to the Pacific Ocean nearshore environment under the Proposed Project is within the historical range of annual sediment supplied to the Pacific Ocean nearshore environment by the Klamath River (USBR 2012; see Potential Impact 3.11-5), the duration of elevated SSCs under the Proposed Project would be greater than the range occurring under natural (i.e., storm) conditions. Natural storm conditions would be expected elevate SSCs in the Pacific Ocean nearshore environment on the time scale of days (Geyer et al. 2000), but SSCs would be elevated in the Pacific Ocean nearshore environment on the time scale of weeks to months based on duration of elevated SSCs modeled in the Klamath River downstream of Iron Gate Dam, at Seiad Valley (RM 132.7), and at Orleans (approximately RM 59) (USBR 2012). Thus, the elevated SSCs created in the nearshore plume under the Proposed Project in the short term would produce variations in the physical characteristics of the Pacific Ocean nearshore environment greater the duration occurring under natural (i.e., storm) conditions, potentially causing water quality changes that would result in a failure to maintain existing beneficial uses at the levels currently supported and resulting in a significant impact to the Pacific Ocean nearshore environment in the short term.

As discussed above for the Hydroelectric Reach and the Middle and Lower Klamath River and the Klamath River Estuary, model results indicate that the SSCs would resume modeled natural background levels by the end of post-dam removal year 1 regardless of the type of hydrology (dry, normal, or wet conditions) present during the drawdown period (USBR 2012). Thus, SSCs in the Pacific Ocean nearshore environment in the long term would be within the range of natural conditions, so the variations in the physical characteristics of the Pacific Ocean nearshore environment similar to natural conditions and there would be no significant impact on SSCs in the long term in the Pacific Ocean nearshore environment due to the release of sediments currently trapped behind the Lower Klamath Project dams. See Section 3.11.5 for analysis of sediment deposition along the nearshore environment due to dam removal.

In summary, the magnitude of SSCs released to the nearshore environment with the anticipated rapid dilution of an expanding sediment plume in the ocean is within the range of natural conditions, but the duration of elevated SSCs is greater than would occur under natural (i.e., storm) conditions. Therefore, elevated SSCs under the

Proposed Project would potentially cause water quality changes that would result in a failure to maintain existing beneficial uses at the levels currently supported, thus short-term increases in SSCs in the Pacific Ocean nearshore environment under the Proposed Project would be significant and unavoidable impact.

The Definite Plan (see Appendix B: *Definite Plan – Appendix M*) includes a Water Quality Monitoring Plan to assess the Proposed Project's impacts to water quality, and this plan includes turbidity and suspended sediment concentration monitoring along with adaptive management requirements. Please note that the State Water Board has authority to review and approve any final Water Quality Monitoring Plan through its water quality certification under Clean Water Act Section 401. The State Water Board has issued a draft water quality certification which sets forth water quality monitoring, adaptive management, and compliance requirements for any Water Quality Monitoring Plan to meet, as Condition 1 and Condition 2[54]. Condition 2 acknowledges that the Proposed Project will have temporary (short-term) exceedances of water quality objectives associated with reservoir drawdown and the export of reservoir sediments into the Klamath River and Pacific Ocean. Restoration projects may exceed water quality objectives in the short term in light of the long-term water quality and ecosystem benefits they provide.

Additionally, the Oregon Department of Environmental Quality has issued a water quality certification[55] that sets forth water quality monitoring and adaptive management conditions for points upstream of California, including an assessment of baseline river conditions upstream of dam removal operations.

Significance

Significant and unavoidable in the short term for the Hydroelectric Reach, Middle Klamath River, Lower Klamath River, Klamath River Estuary, and Pacific Ocean nearshore environment

No significant impact in the long term for the Hydroelectric Reach, Middle Klamath River, Lower Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environment.

Potential Impact 3.2-4 Increases in suspended material from stormwater runoff due to pre-construction, dam deconstruction and removal, and restoration activities in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam.

Under the Proposed Project, pre-construction activities with the potential to affect water quality include canal and diversion tunnel modifications, road improvements, Iron Gate and Fall Creek hatchery modifications, Yreka pipeline modifications, and dam site preparation between June and November of dam removal year 1 (Table 2.7-1). Dam removal activities would begin in October of dam removal year 1 with removal of the Copco No. 1 Powerplant and would include demolition of the dams and their associated

[54] The State Water Board's draft water quality certification is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 11, 2018).

[55] The Oregon Department of Environmental Quality's final water quality certification is available online at: https://www.oregon.gov/deq/FilterDocs/ferc14803final.pdf (Accessed December 14, 2018).

structures, power generation facilities, and transmission lines, installation of temporary cofferdams, hauling, recreation facilities removal, regrading of recreation access roads and parking areas, and other activities (Table 2.7-1). Immediately following dam removal, any potential non-natural fish barriers within the historical reservoir footprints would be modified as needed to enable volitional fish passage, which may include in-water work. Restoration activities would include irrigation system installation and maintenance, as well as active seeding, planting, and weed management in the reservoir footprint and disturbed upland areas within the Limits of Work (Table 2.7-1). For greater detail on these activities, please see Section 2.7 *Proposed Project*. All of the aforementioned activities could result in the disturbance of soil within the Limits of Work and result in loose sediment that could then be suspended in stormwater runoff during rainfall events. Please see Potential Impacts 3.2-16 and 3.22-2 for consideration of the accidental release of hazardous materials from construction equipment and/or vehicles under the Proposed Project.

Within the Limits of Work (Figures 2.2-5, 2.7-1, and 2.7-3), the Proposed Project includes the following construction and other ground-disturbing activities best management practices (BMPs) to reduce potential impacts to water quality in wetlands and other surface waters during construction and other ground-disturbing activities (Appendix B: *Definite Plan – Appendix J*):

- Pollution and erosion control measures will be implemented to prevent pollution caused by construction operations and to reduce contaminated stormwater runoff.
- Oil-absorbing floating booms will be kept onsite, and the contractor will respond immediately to aquatic spills during construction.
- Vehicles and equipment will be kept in good repair, without leaks of hydraulic or lubricating fluids. If such leaks or drips do occur, they will be cleaned up immediately.
- Equipment maintenance and/or repair will be confined to one location at each project construction site. Runoff in this area will be controlled to prevent contamination of soils and water.
- Dust control measures will be implemented, including wetting disturbed soils.
- A Stormwater Pollution Prevention Plan (SWPPP) will be implemented to prevent construction materials (fuels, oils, and lubricants) from spilling or otherwise entering waterways or waterbodies.

In addition, for the protection of wetlands, results of a wetland delineation would be incorporated into the Proposed Project design to avoid and minimize direct impacts on wetlands to the maximum extent feasible, and wetland areas adjacent to the construction Limits of Work would be fenced. As discussed in Potential Impact 3.5-1, there could be impacts to wetlands if the fencing does not include an appropriate buffer; implementation of Mitigation Measure TER-1, which stipulates a minimum 20-foot buffer requirement, would reduce potential short-term impacts on wetland communities to less than significant.

The BMPs identified above focus on general stormwater-related contamination, but their implementation is expected to also minimize or eliminate the potential for construction-related increases in suspended material that could enter wetlands and other surface waters located within the Limits of Work (Figures 2.2-5, 2.7-1, and 2.7-3), including the Hydroelectric Reach, tributaries of the Klamath River that enter this reach (as appropriate), or the Middle Klamath River immediately downstream of Iron Gate Dam. The Proposed Project does not, however, specifically identify BMPs for pre-construction, reservoir restoration, or upland restoration activities that would occur within the Limits of Work. Further, the proposed BMPs are not sufficiently comprehensive to avoid all potential violations of water quality standards or other degradation of water quality in affected portions of the wetlands, Hydroelectric Reach, tributaries to the Klamath River that enter this reach (as appropriate), or the Middle Klamath River immediately downstream of Iron Gate Dam, during these other periods of Proposed Project activity. Such violations of water quality standards or other related degradation of water quality would be a significant impact without mitigation. Implementation of mitigation measures WQ-1, TER-1, and HZ-1 would reduce any potential impacts not already addressed by the BMPs to less than significant.

Mitigation Measure WQ-1 Best Management Practices to reduce potential impacts to water quality due to pre-construction, dam removal, and restoration-related activities.
For the protection of all potentially affected waterbodies within the Limits of Work (see Figures 2.2-5, 2.7-2, and 2.7-4), the proposed construction BMPs (listed above) shall apply to all ground-disturbing activities occurring for the Proposed Project. Construction associated with these activities shall be subject to the BMPs required under the Construction General Permit.

Significance
No significant impact with mitigation

Potential Impact 3.2-5 Long-term alterations in mineral (inorganic) suspended material from the lack of continued interception and retention by the dams.
Under the Proposed Project, peak concentrations of mineral (inorganic) suspended material (silts and clays with a diameter less than 0.063 millimeters) during the winter/early spring (November through April) would likely continue to be associated with high-flow events following dam removal. Any long-term increases in mineral (inorganic) suspended material due to the lack of interception by the dams would not be large; estimates of baseline sediment delivery for the Klamath Basin indicate that a relatively small fraction of total sediment (151,000 tons per year or 2.4 percent of the cumulative average annual delivery from the basin) is supplied to the Klamath River on an annual basis from the watershed upstream of Iron Gate Dam due to the generally lower rates of precipitation and runoff, more resistant and permeable geologic terrain, and relatively low topographic relief and drainage density of the Upper Klamath Basin as compared with the lower basin (Stillwater Sciences 2010) (see also Section 3.11.2.4 Sediment Load). The majority of the mineral (inorganic) suspended material (6,086,471 tons per year or 97.6 percent of the cumulative average annual delivery from the basin) enters the Klamath River from tributaries downstream of Iron Gate Dam which is a pattern that is expected to continue following dam removal.

Long-term increases in suspended material from the lack of continued interception and retention of mineral (inorganic) suspended materials by the Lower Klamath dam are not expected to cause an exceedance or exacerbate an existing exceedance of a water quality standard or result in a failure to maintain a beneficial use. Accordingly, for the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment, there would be a less than significant long-term impact from removal of the dams on amounts or concentrations of mineral (inorganic) suspended material.

Significance

No significant impact

Potential Impact 3.2-6 Long-term alterations in algal-derived (organic) suspended material from the lack of continued interception and retention by the dams.
As discussed in Section 3.2.2 *Environmental Setting*, Section 3.4.2 *[Phytoplankton and Periphyton] Environmental Setting*, and Appendix C, Section C.2.1 *Upper Klamath Basin*, Upper Klamath Lake is a hypereutrophic system with considerable algae growth and suspended organic matter. Under existing conditions, the majority of the interception and retention of suspended material from upstream sources (Upper Klamath Lake, Klamath Straights Drain, Lost River) occurs in the Keno Impoundment/Lake Ewauna, with the largest relative decreases in TSS (total suspended solids) occurring between Link River and Keno Dam (see Appendix C, Figure C-13). In addition to interception by the dams, concentrations of organic suspended material from upstream decrease in the rivers due to mechanical breakdown of dead and decaying algae in the turbulent river reaches between J.C. Boyle and Copco No. 1 reservoirs, and dilution from the springs downstream from J.C. Boyle Dam (see Appendix C, Section C.2.1). Mechanical breakdown and dilution from springs are ongoing processes that would continue under the Proposed Project.

Episodic increases (10 to 20 mg/L) in algal-dominated (organic) suspended material resulting from in-reservoir algal productivity are not expected to occur in the Hydroelectric Reach following dam removal (see Section 3.2.2.3 *Suspended Sediments*). At the upstream end of the Hydroelectric Reach (i.e. at the upstream of J.C. Boyle Reservoir) and prior to mechanical breakdown or dilution downstream of J.C. Boyle Dam, suspended materials may attain levels similar to those observed upstream of J.C. Boyle Dam under existing conditions during May through October (greater than 15 mg/L; see Appendix C) as algal-dominated organic suspended material is transported downstream. In the Hydroelectric Reach downstream of the J.C. Boyle Dam location to Iron Gate, mechanical breakdown in the existing and newly created free-flowing river reaches, along with dilution, would be likely to reduce concentration of algal-derived (organic) suspended material, but the exact magnitude of the reduction in algal-derived (organic) suspended material cannot be quantified with available data or models. Measurements of organic suspended sediment between 2001 and 2003 and median turbidity values over the long-term historical record (1950–2001) both follow a similar pattern, with values decreasing with distance downstream to J.C. Boyle Reservoir, indicating it is likely that the suspended sediment concentrations crossing the Oregon-California state line under the Proposed Project would not increase beyond typical existing conditions concentrations of 10 to 15 mg/L (see Section 3.2.2.1 and Appendix C, Section C.2).

While it is likely that mechanical breakdown and dilution within the Hydroelectric Reach would reduce algal-derived (organic) suspended material concentrations entering the Hydroelectric Reach, it is conservatively assumed no decrease in algal-derived (organic) suspended material would occur within the Hydroelectric Reach due to the reservoirs no longer providing calm, slow-moving water conditions for algal-derived (organic) suspended material to settle out of the water column. Thus, downstream of Iron Gate Dam, there potentially would be a slight relative long-term increase in algal-dominated (organic) suspended materials under the Proposed Project, due to the conservative assumption that there would be no decrease in suspended material through the Hydroelectric Reach.

Following completion of the Proposed Project, it is very unlikely that summertime algal-dominated (organic) suspended material in the Middle and Lower Klamath River would increase beyond a sustained 100 mg/L for two weeks (the water quality criterion adopted for significant adverse impacts on the COLD beneficial use for the Lower Klamath Project EIR analysis (see Section 3.2.3.1). If slight long-term increases in suspended materials did occur, such increases would be well below the algal-derived suspended material previously produced in Copco No. 1 and Iron Gate reservoirs and would not exceed levels that would substantially adversely affect the cold freshwater habitat (COLD) beneficial use or any other existing designated beneficial use at the levels currently supported, exacerbate an existing exceedance of water quality standards, or result in a failure to maintain an existing beneficial use.

Significance
No significant impact

3.2.5.3 Nutrients

Potential Impact 3.2-7 Short-term increases in sediment-associated nutrients due to release of sediments currently trapped behind the dams.
Hydroelectric Reach, Middle and Lower Klamath River, and Klamath River Estuary
As discussed in Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*, a significant portion of the sediment anticipated to be removed during reservoir drawdown is dead phytoplankton [algae] that have settled on the reservoir bottom. These sediments are very high in nutrients. Short-term increases in total nitrogen (TN) and total phosphorus (TP) concentrations in the Hydroelectric Reach, Middle Klamath River, Lower Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environment would occur because the transported sediments are nutrient-rich. However, minimal deposition of fine suspended sediments, including associated nutrients, would occur in the river channel and the estuary (USBR 2012; Stillwater Sciences 2008). Further, reservoir drawdown under the Proposed Project would occur during winter months when rates of primary production and microbially mediated nutrient cycling (e.g., nitrification, denitrification) are also expected to be low, such that nutrient uptake potential in the river reaches will be low during drawdown. Light limitation for primary producers that do persist during winter months is also likely to occur because of high turbidity; this would further decrease the potential for uptake of the TN and TP that are released along with reservoir sediment deposits. While there would be a temporary upward pulse in TP and TN away from the numeric TMDL targets, this pulse would not support the growth of nuisance and/or noxious phytoplankton or nuisance periphyton. Particulate nutrients released along with sediment deposits are not expected to be bioavailable, should be well-conserved during transport through the mainstem river and the estuary, therefore in the short-term sediment-associated TP and TN are not expected result in a failure to maintain a beneficial use, or cause an exceedance or exacerbate an existing exceedance of a water quality. Overall, this would be a less than significant short-term impact.

Pacific Ocean Nearshore Environment

Under the Proposed Project, fine sediments and associated nutrients released during reservoir drawdown would be dispersed as a buoyant river plume into the Pacific Ocean nearshore environment, where the sediments and associated nutrients would likely deposit along the continental shelf in the vicinity of the mouth of the Klamath River. Similar to conditions in the Klamath River and Klamath River Estuary, the biostimulatory effect of nutrient uptake from suspended or recently deposited fine sediments is expected to be low in the Pacific Ocean nearshore environment because reservoir drawdown would occur in winter when light availability is relatively low and primary productivity (i.e., phytoplankton growth) and microbially-mediated nutrient cycling are correspondingly low. In the summer following drawdown (dam removal year 2), resuspension of nutrients deposited on the continental shelf by coastal upwelling would make a negligible contribution to overall nutrient availability in the Pacific Ocean nearshore environment. This is because coastal upwelling near the mouth of the Klamath River supplies approximately 1,700 tons to 4,000 tons of nitrate per day per 100 meters of coastline, and approximately 225 tons to 450 tons of phosphate per day per 100 meters of coastline, using estimates for average California Current coastal upwelling near the Klamath River latitude (Bruland et al. 2001) and typical nutrient concentrations in coastal upwelling off the California coast (Bograd et al. 2009). Lower Klamath Project reservoir sediments would deposit between 1,200 tons to 5,500 tons of TN and 190 tons to 680 tons of TP along the continental shelf in the Pacific Ocean nearshore environment, based on the range of sediment TN (130 mg/kg to 2,800 mg/kg) and sediment TP (92 mg/kg to 370 mg/kg) from reservoir sediment cores (USBR 2011) and the range of sediment expected to erode during dam removal (1,460,000 tons to 2,310,000 tons; see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown* and USBR [2012]). While only a fraction of the nutrients deposited on the continental shelf would have the potential to be resuspended during summer coastal upwelling, more nutrients would be supplied to marine nearshore surface waters by coastal upwelling in two days than the maximum amount of nutrients associated with the Lower Klamath Project reservoir sediments that would be mobilized during dam removal.

In addition to TN and TP, micronutrients in the Lower Klamath Project reservoir sediments could act as biostimulatory substances in the Pacific Ocean nearshore environment, where micronutrient availability can limit biological production in coastal waters (Bruland et al. 1991). Iron in the Lower Klamath Project reservoir sediments is the most abundant micronutrient that could influence phytoplankton productivity in the Pacific Ocean nearshore environment, since iron is important in photosynthetic and respiratory electron transport, nitrate reduction, and N-fixation (Morel et al. 1991; Bruland et al. 2001; Street and Paytan 2005). Iron is typically supplied at very low rates (0.04 tons to 0.10 tons per day per 100 meters of coastline) by coastal upwelling (Bruland et al. 2001; Bograd et al. 2009), such that river discharges are the primary source of iron to the California nearshore coastal environment (Bruland et al. 2001). During high-flow winter conditions, iron associated with riverine suspended particles is delivered to the continental shelf, and during summer, iron is remobilized by coastal upwelling (Chase et al. 2007). In coastal regions with large riverine inputs and a broad continental shelf, phytoplankton productivity in the Pacific Ocean nearshore environment is not considered to be iron-limited, since the combination of riverine supply and continental shelf storage can meet phytoplankton iron needs through particle resuspension (Chase et al. 2005; Lohan and Bruland 2006). Coastal regions with narrower shelves (less storage) and lower river discharge (less supply) can have iron-limited phytoplankton productivity (Hutchins and Bruland 1998; Bruland et al. 2001).

Studies of iron availability along the Oregon coast (Chase et al. 2007) and the central California coast between Monterey Bay and Point Reyes (Bruland et al. 2001) have found the shape of the continental shelf in those regions to be sufficiently large that enough iron can be stored from winter deposition that the Pacific Ocean nearshore environment is not iron-limited. Narrower continental shelf regions, like those found along the central California coast near Big Sur, have been found to be iron-limited (Bruland et al. 2001). The iron availability in the Pacific Ocean nearshore environment at the mouth of the Klamath River is unknown, but the shape of the continental shelf near the mouth of the Klamath River is similar to the shape of the continental shelf along the Oregon coast and central California coast between Monterey Bay and Point Reyes, suggesting that Pacific Ocean nearshore environment along the Klamath River is not iron-limited.

Estimates of typical sediment transport to the Pacific Ocean nearshore environment from the Mid- and Lower Klamath Basin downstream of Iron Gate Dam (Stillwater Sciences 2010) combined with estimates of the iron content of soils in the Mid- and Lower Klamath Basin (USGS NGS 2008) indicate that the total iron delivered to the nearshore coastal environment and the continental shelf near the Klamath River ranges from approximately 194,000 tons to 390,000 tons per year. Estimates of the amount of sediment expected to be released during dam removal (Table 2.7-11) combined with estimates of the iron content of the sediment trapped behind the Lower Klamath Project dams (8,200 mg/kg to 32,000 mg/kg; USBR 2011) indicate that an additional 23,000 tons to 62,000 tons of iron would be contributed to the Pacific Ocean nearshore environment by sediment released during dam removal. The 6 percent to 32 percent short-term increase in total iron loading to the Pacific Ocean nearshore environment as a result of Lower Klamath Project dam removal would not significantly alter iron nutrient conditions in the Pacific Ocean nearshore environment, since only a fraction of the iron would be resuspended by coastal upwelling and only a fraction of the resuspended iron would occur in a bioavailable form (Morel et al. 1991; Bruland et al. 2001; Buck et al. 2007).

Overall, the short-term increases in sediment-associated nutrients (TN and TP) would be less than significant because any biostimulatory effects would be limited in winter months by naturally low phytoplankton productivity and diluted in summer months by much higher background levels of resuspended nutrients supplied by coastal upwelling. Short-term increases in sediment-associated micronutrients (iron) also would be less than significant since iron-limitation of phytoplankton is not expected to occur in the Pacific Ocean nearshore environment near the mouth of the Klamath River, and the additional iron loading from Lower Klamath Project sediment deposits would be small compared to typical annual iron loading rates from natural erosion processes in the Mid- and Lower Klamath Basin. Thus, TP and TN in the reservoir sediment releases would not cause objectionable aquatic growths or degrade indigenous biota (see Table 3.2-6), and these nutrients are not expected result in a failure to maintain a beneficial use or cause an exceedance or exacerbate an existing exceedance of a water quality.

The Definite Plan (see Appendix B: *Definite Plan – Appendix M*) includes a Water Quality Monitoring Plan to assess the Proposed Project's impacts to water quality, and this plan includes monitoring of total nitrogen and total phosphorous. Please note that the State Water Board has authority to review and approve any final Water Quality Monitoring Plan through its water quality certification under Clean Water Act Section

401. The State Water Board has issued a draft water quality certification which sets forth monitoring and adaptive management requirements for any Water Quality Monitoring Plan to meet, as Condition 1[56]. Additionally, the Oregon Department of Environmental Quality has issued a water quality certification[57] that sets forth water quality monitoring and adaptive management conditions for points upstream of California. This EIR does not find that the effect of the Proposed Project on sediment-associated nutrients would be significant in either the short or the long term, and this analysis of Potential Impact 3.2-7 does not further discuss the water quality monitoring and adaptive management conditions.

Significance

No significant impact

Potential Impact 3.2-8 Long-term alterations in nutrients from the lack of interception and retention by the dams and conversion of the reservoir areas to a free-flowing river.

The two largest reservoirs in the Lower Klamath Project (Copco No. 1 and Iron Gate reservoirs) intercept and retain suspended material behind the dams, including nutrients (TP and TN) originating from upstream. Under the Proposed Project, these nutrients would be transported downstream and potentially be available for biological uptake (e.g., by periphyton [attached algae]). Analyses of the impacts of dam removal on nutrients have been conducted by PacifiCorp for its relicensing efforts (FERC 2007), the North Coast Regional Board for development of the California Klamath River TMDLs (North Coast Regional Board 2010), and the Yurok Tribe (Asarian et al. 2010) as part of an evaluation to improve previous nutrient budgets for the Klamath River and increase understanding of nutrient retention rates in free-flowing river reaches.

Hydroelectric Reach

The results of all the above-referenced evaluations (FERC 2007, North Coast Regional Board 2010, and Asarian et al. 2010) recognize the trapping efficiency of Copco No. 1 and Iron Gate reservoirs with respect to annual TP and TN, such that under the Proposed Project total nutrient concentrations in the Klamath River downstream from Iron Gate Dam would increase on an annual basis. However, the majority of the existing analyses results are focused on the Middle and Lower Klamath River downstream from Iron Gate Dam, rather than on the Hydroelectric Reach.

Modeling conducted for development of the California Klamath River TMDLs (North Coast Regional Board 2010) does provide some information applicable to the assessment of long-term impacts of the Proposed Project on nutrients at locations in the Hydroelectric Reach (Kirk et al. 2010). Klamath River TMDL model results indicate that if the Lower Klamath Project dams were to be removed ("TMDL dams-out, Oregon" [TOD2RN] scenario), TP and TN in the Hydroelectric Reach immediately downstream from J.C. Boyle Dam would increase slightly (by less than 0.015 mg/L TP and less than 0.05 mg/L TN) during summer months compared to existing conditions ("TMDL dams-in"

[56] The State Water Board's draft water quality certification is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 14, 2018).

[57] The Oregon Department of Environmental Quality's final water quality certification is available online at: https://www.oregon.gov/deq/FilterDocs/ferc14803final.pdf (Accessed December 14, 2018).

[T4BSRN] scenario). This slight increase is due to the absence of nutrient interception and retention in both Keno Impoundment/Lake Ewauna and J.C. Boyle Reservoir. With respect to conditions in Keno Impoundment/Lake Ewauna, the Klamath River TMDL model assumes that the upstream Keno Dam is replaced by the historical natural Keno Reef in the "TMDL dams-out" scenario (TOD2RN and TCD2RN) but not in the "TMDL dams-in" scenario (T4BSRN). In the model, the Keno Reach is still partially impounded even though the reef's elevation is two feet lower than the current full pool elevation of Keno Impoundment/Lake Ewauna. While the Klamath River TMDL model assumption regarding Keno Reef does not materially influence model applicability to inform impact determinations for the Proposed Project and alternatives identified in this EIR, it could mean that the slight predicted increase in TP and TN under the modeled "TMDL dams-out" scenario (TOD2RN and TCD2RN) is an over-estimate under the Proposed Project, which does not propose any changes to Keno Dam, such that TP and TP concentrations in the Hydroelectric Reach immediately downstream from J.C. Boyle Dam would be the same as under existing conditions.

At the Oregon-California state line, the total nutrient supply also would be essentially the same under the Proposed Project as under existing conditions. The lack of hydropower peaking operations at J.C. Boyle Dam under the Proposed Project may result in decreased daily variation in TP and TN (North Coast Regional Board 2010). Overall however, the predicted nutrient changes are very small and thus this effect of the Proposed Project is not considered to be of potential benefit. Further, the Klamath River TMDL model predictions generally agree with empirical data regarding J.C. Boyle Reservoir; with its shallow depth and short residence time, this reservoir does not retain high amounts of nutrients (PacifiCorp 2006a) (see Appendix C for more detail) and its removal would not be expected to increase long-term nutrient transport in the Hydroelectric Reach downstream of the Oregon-California state line.

It is important to note that the Klamath River TMDL model scenarios are useful for informing impacts associated with the Proposed Project and alternatives identified in Section 4 *Alternatives*, but they include as a starting assumption that there will be full implementation of the TMDLs. For example, the "TMDL dams-in" (T4BSRN) and "TMDL dams-out" (TOD2RN) scenarios for California both assume that water entering into California from Oregon meets California water quality standards for water temperature, organic enrichment/low dissolved oxygen, nutrients, pH, and microcystin. In other words, the starting point for the California models is that all necessary reductions in pollution to address the current impaired conditions at the Oregon-California state line for these constituents would already have been implemented upstream. The full TMDL compliance modeling assumption does not reflect the existing conditions, and it would be speculative at this point to identify either the mechanisms necessary to implement the TMDLs or the timing required to achieve full compliance. However, the nutrient retention mechanism modeled in the Klamath River TMDL would be the same even if model inputs for nutrients were increased to concentrations under existing conditions, such that the general trend indicated by the Klamath River TMDL model output (i.e., dam removal would slightly increase downstream transport of total nutrients) is still informative for conditions where full TMDL compliance has not occurred.

Based on available information, the slight nutrient increases in the Hydroelectric Reach would not be expected to result in exceedances of California North Coast Regional Board Basin Plan water quality objectives for biostimulatory substances beyond levels experienced under existing conditions. Further, the elimination of seasonal releases of dissolved forms of nutrients from anoxic reservoir bottom waters during periods of reservoir stratification would reduce nutrient availability for supporting large summer and fall phytoplankton blooms, including blue-green algae blooms, in Copco No. 1 and Iron Gate reservoirs (see also discussion for *Middle and Lower Klamath River and Klamath River Estuary*). While seasonal periphyton colonization would likely increase in this reach under the Proposed Project, the increases would be due to habitat increases (i.e., conversion of a reservoir into a riverine habitat) rather than nutrient increases (see Potential Impact 3.4-4). Further, the reservoir environment that supports the growth of nuisance phytoplankton blooms such as *Microcystis aeruginosa* and other blue-green algae would be eliminated under the Proposed Project (see Section 3.4 *Phytoplankton and Periphyton*), reducing the possibility of uptake of the slightly increased total nutrient concentrations by any nuisance and/or noxious phytoplankton blooms that might, however unlikely, occur in the riverine reaches that replace the reservoirs. The nuisance phytoplankton problem is mainly relevant for Copco No. 1 and Iron Gate reservoirs, where the longer residence times support seasonal nuisance phytoplankton blooms (see Section 3.4 *Phytoplankton and Periphyton*). Thus, under the Proposed Project, there would be a less than significant long-term increase in total nutrient levels in the Hydroelectric Reach from the lack of continued interception by the Lower Klamath Project dams and conversion of the reservoir areas to a free-flowing river, and a beneficial effect of eliminating seasonal releases of dissolved forms of nutrients from anoxic reservoir bottom waters.

Middle and Lower Klamath River and Klamath River Estuary

As described above in this potential impact analysis, Copco No. 1 and Iron Gate reservoirs currently intercept and retain suspended material behind the dams, including nutrients (TP and TN) associated with suspended material that originates upstream of the Hydroelectric Reach. Results of all the existing evaluations (FERC 2007; North Coast Regional Board 2010; Asarian et al. 2010) recognize the trapping function of the reservoirs with respect to TP and TN, and they provide results indicating that ending this trapping by converting the reservoirs to free-flowing river reaches would, on an annual basis, result in a slight increase in *annual* TN and TP in the Middle and Lower Klamath River and the Klamath River Estuary. On a *seasonal* basis, the reservoirs can be a source of TP and TN in the form of dissolved nutrients (e.g., ortho-phosphorus, nitrate, and ammonium) to the Middle Klamath River, as nutrients contained within bottom sediments are released back into the water column under low dissolved oxygen conditions (see also Section 3.2.2.1 *Overview of Water Quality Processes in the Klamath Basin* and Figure 3.2-2). For example, in an analysis of nutrient dynamics in the Klamath River comparing the Klamath River TMDL model output against available empirical studies, while the *annual* modeled TP retention rate was approximately 6 percent for Iron Gate Reservoir and 1 percent for Copco No. 1, the model results indicated a *seasonal* TP release (2 percent to 40 percent) from Iron Gate Reservoir during late summer/fall, with the highest release (40 percent) occurring at reservoir fall turnover (see Figure 3.2-2 for a schematic of reservoir turnover), and a *seasonal* TP release (2 percent to 26 percent) from Copco No. 1 Reservoir during late summer/fall and into winter months. Similarly, albeit to a lesser degree, the *annual* modeled TN retention was approximately 18 percent for Iron Gate Reservoir, with a 4 percent *seasonal* release of TN in winter of the model year. For Copco No. 1, the annual modeled TN retention was 4 percent for Copco No. 1, with a *seasonal* release of 3 to 15 percent in winter months (North Coast Regional Board 2010, Appendix 3). Asarian et al. (2009) notes that the seasonal release of nutrients can occur periodically between the late summer and early winter, but on balance the annual retention of nutrients is greater than the seasonal releases.

Based on the Yurok Tribe analysis (Asarian et al. 2010), TP concentrations in the Middle and Lower Klamath River would increase by approximately 2 to 12 percent for the June–October period if the dams were to be removed, while increases in TN concentrations would be relatively larger, at an estimated 37 to 42 percent for June through October and 48 to 55 percent for July through September (see Figure 3.2-18). The Yurok Tribe conducted their analysis using two different approaches: (1) calculated reach-specific nutrient retention rates based on measured nutrient concentration data, and (2) predicted retention rates using an empirical relationship between observed retention rates and measured concentrations developed for the river from Iron Gate Dam to Turwar (this approach was only applicable to TN because TP data demonstrated a weak relationship between retention rate and measured TP concentrations). The two approaches used by the Yurok Tribe implicitly include nutrient recycling processes such as assimilative uptake for seasonal phytoplankton and periphyton growth and subsequent downstream release, as these processes were ongoing and inherently included in the retention estimates determined for existing conditions. The first (and only TP-applicable) approach indicated small increases in TP concentrations downstream from Iron Gate Dam under the Proposed Project, and a diminishment of this effect with distance downstream due to both tributary dilution and nutrient retention (i.e., uptake of nutrients). Both approaches yielded similar TN results, indicating relatively larger increases in TN concentrations than the TP concentration, following the same diminishment pattern due to dilution and nutrient retention.

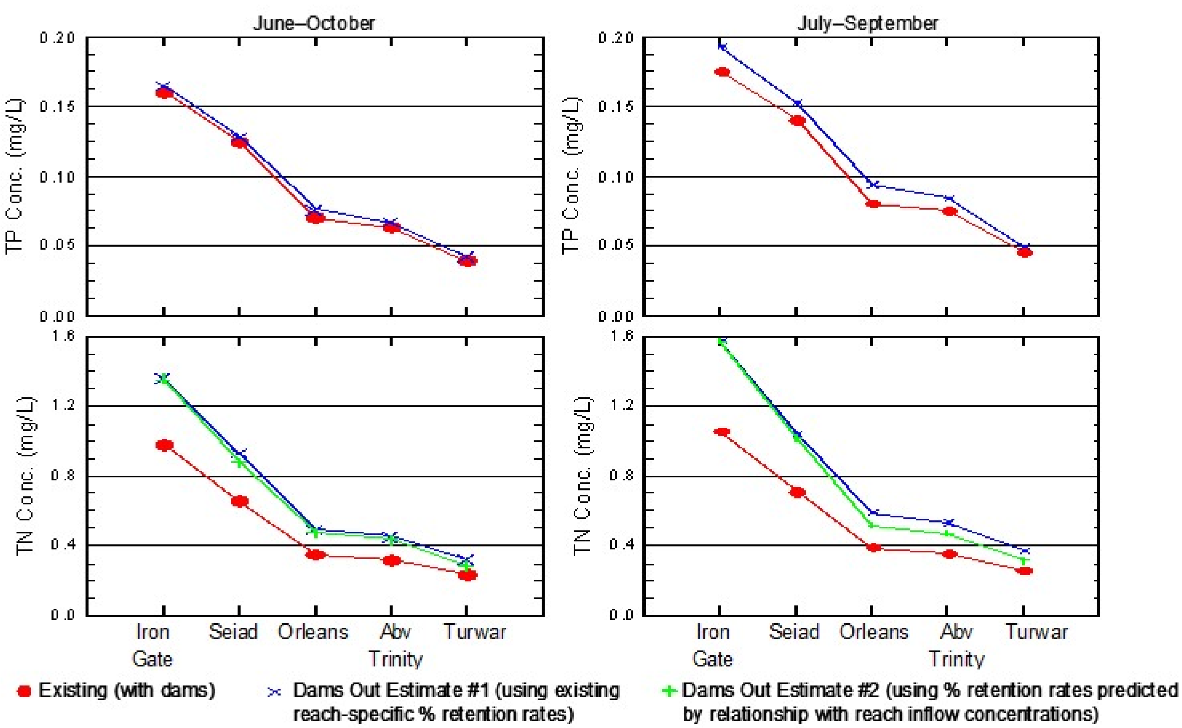

Figure 3.2-18. Comparison of Annual TP and TN Concentrations from Iron Gate Dam to Turwar (RM 5.6) for June–October and July–September 2007–2008: (a) Measured Current Conditions (Red Circle), (b) Dams-Out Estimate using Calculated Percent Retention Rates by Reach (Blue Cross), and (c) Dams-Out Estimate

using Percent Retention Rates Predicted by the Empirical Relationship between Reach Inflow Concentration and Retention (Green Cross). Source: Asarian et al. 2010.

Unlike the Yurok Tribe analysis, the Klamath River TMDL modeling efforts include an assumption of full compliance with upstream TP and TN load allocations for California (North Coast Regional Board 2010). Despite this, results of the Klamath River TMDL model are in general agreement with PacifiCorp (FERC 2007) and Yurok Tribe (Asarian et al. 2010) analyses regarding dam removal impacts on nutrients, with very small annual increases in TP (0.01 to 0.015 mg/L) and relatively larger annual increases in TN (0.1 to 0.125 mg/L) immediately downstream from Iron Gate Dam due to dam removal. Increases in nutrients would diminish with distance downstream from Iron Gate Dam. It should be noted that while following the same relative trend as the Yurok Tribe analysis, the absolute increases predicted by the Klamath River TMDL model for the "TMDL dams-out" California scenario (TCD2RN) are much lower (e.g., 0.1–0.125 mg/L TN increase for the TMDL model vs. 0.1 to 0.5 mg/L TN increase for the Yurok Tribe analysis). This finding is in accord with the prediction in Asarian et al. (2010) that decreased nutrient input into California would decrease the annual TN and TP effect of dam removal.

Variability in TP and TN are predicted by the Klamath River TMDL model (see Appendix D) under the "TMDL dams-out" California scenario (TCD2RN) during summer months, presumably due to nutrient uptake dynamics by periphyton and macrophytes in the free-flowing river segments that would replace the reservoirs. The Klamath River TMDL model does not include denitrification as a possible nitrogen removal term in river segments (Tetra Tech 2009), meaning that TN concentrations being transported into the Middle Klamath River under the Proposed Project may be over-predicted. The magnitude of this potential over-prediction would be expected to increase with distance downstream (i.e., relatively lower over-prediction at Iron Gate Dam and the Upper Klamath Basin, but relatively higher over-prediction at sites in the lowest portion of the Klamath River such as Orleans), due to a longer distance of river within which denitrification and other nitrogen removal processes would operate. Corresponding small differences in ortho-phosphorus, nitrate, and ammonium concentrations under the Proposed Project (as compared with existing conditions, including TMDL compliance) are predicted by the Klamath River TMDL model; however, within the uncertainty of future nutrient dynamics these differences are not clearly discernable as increases or decreases. Klamath River TMDL model results indicate that while resulting TP levels would meet the existing Hoopa Valley Tribe numeric water quality objective (0.035 mg/L TP) in all months at the Hoopa reach (approximately RM 45) of the Klamath River, TN levels would continue to be in excess of the existing objective (0.2 mg/L TN) in all months, as would TN levels for the modeled "natural conditions" (T1BSR) and the modeled "dams-in" scenario (T4BSRN) (for the months of October through June) (North Coast Regional Board 2010). However, as noted previously, TN concentrations in the model may be over-predicted and therefore the Hoopa Valley Tribe objective may be met.

While there would be a slight increase in absolute nutrient concentrations entering the Middle Klamath River under the Proposed Project, phytoplankton, especially blue-green algae, would be limited in their ability to use those nutrients for growth and reproduction without calm reservoir habitat (Potential Impact 3.4-2). Further, the elimination of potential seasonal releases of dissolved forms of nutrients from anoxic reservoir bottom waters and into downstream reaches of the Klamath River would reduce nutrient availability for phytoplankton during the growing season. Overall, the slight increase in annual nutrient concentrations would not result in significant biostimulatory impacts on phytoplankton growth under the Proposed Project relative to existing conditions, and the elimination of potential seasonal releases of dissolved nutrients from the reservoir bottom waters would be beneficial.

For periphyton, despite the overall increases in absolute nutrient concentrations anticipated under the Proposed Project, the small but relatively greater increases in TN also may not result in significant biostimulatory impacts during the growth season (i.e., late spring through fall). Existing data regarding TN:TP ratios suggest the potential for the Klamath River to be N-limited to the extent that there is a nutrient limitation. However, concentrations of both nutrients are high enough in the Klamath River from Iron Gate Dam to approximately Seiad Valley (RM 132.7) (and potentially further downstream) that nutrients are not likely to be limiting primary productivity (e.g., periphyton growth) in this more upstream portion of the Middle Klamath River (FERC 2007, HVTEPA 2008, Asarian et al. 2010). In addition, N-fixing species dominate the periphyton communities in the lower portions of the Middle Klamath River as well as the Lower Klamath River where inorganic nitrogen concentrations are low (Asarian et al. 2010, 2014, 2015). Since these species can fix their own nitrogen from the atmosphere, increases in TN due to dam removal may not significantly increase algal biomass in these reaches (see also Section 3.4 *Phytoplankton and Periphyton*).

In general, although dam removal would result in a slight long-term increase in TP and TN away from the numeric targets, such an increase would not support the growth of nuisance and/or noxious phytoplankton or nuisance periphyton. Therefore, in the long term the lack of continued interception of TN and TP on an *annual* basis by the Lower Klamath Project dams and conversion of the reservoir areas to a free-flowing river would not result in a failure to maintain a beneficial use or cause an exceedance or exacerbate an existing exceedance of a water quality. Overall, this would be a less than significant long-term impact. The elimination of potential seasonal releases of dissolved nutrients from the reservoir bottom waters to downstream reaches of the Klamath River would be beneficial.

Pacific Ocean Nearshore Environment

Copco No. 1 and Iron Gate reservoirs currently intercept and retain suspended material behind the dams, including nutrients (TN, TP) and micronutrients (iron) that are potentially important for phytoplankton growth in the Pacific Ocean nearshore environment. Similar to conditions in the Middle and Lower Klamath River and Klamath River Estuary, under the Proposed Project the Pacific Ocean nearshore environment also would experience a small increase in total annual nutrient concentrations on an annual basis since nutrients would no longer be trapped upstream by the Lower Klamath Project dams. The slight nutrient increases would not be expected to result in exceedances of water quality objectives for biostimulatory substances beyond levels experienced under existing conditions for the reasons described under Potential Impact 3.2-7 in the Pacific Ocean nearshore environment (because in the winter any biostimulatory effect would be limited by low productivity and light availability and during summer, any increase in nutrients in the Pacific Ocean nearshore environment would amount to considerably less than the background supply of nutrients from coastal upwelling (Bruland et al. 2001; Bograd et al. 2009). Overall, under the Proposed Project, there would be a less than significant long-term increase in nutrients in the Pacific Ocean nearshore environment due to the lack of continued interception by the Lower Klamath Project dams and conversion of the reservoir areas to a free-flowing river.

Significance

No significant impact in the long term due to lack of annual interception and retention of total nutrients

Beneficial in the long term due to elimination of potential seasonal releases of dissolved nutrients

3.2.5.4 Dissolved Oxygen

Potential Impact 3.2-9 Short-term increases in oxygen demand and reductions in dissolved oxygen due to release of sediments currently trapped behind the dams.

Hydroelectric Reach

Under the Proposed Project, high SSCs are expected to occur along the reaches of the Klamath River downstream of reservoirs and within the Klamath Estuary during and following drawdown (see Potential Impact 3.2-3). Because reservoir sediment deposits contain unoxidized organic matter from algal detritus (see Section 3.2.2.3 *Suspended Sediments*), resuspension of these materials during reservoir drawdown is likely to reduce oxygen concentrations in downstream reaches until oxygen consumption is balanced by reaeration as the river continues to flow. To put it more in terms of biochemical processes, decomposition of algal detritus is facilitated by natural bacteria associated with reservoir sediments. Once suspended during dam removal and exposed to the water column, these sediments would result in an oxygen demand generated by microbial oxidation and as well as chemical oxidation of reduced mineral compounds in the sediment (e.g., sulfides), especially from deeper in the sediment profile.

To estimate the potential magnitude of oxygen depletion and recovery at various SSC levels along the Klamath River, a modeling approach was adapted from Streeter and Phelps (1925) including laboratory estimates of dissolved oxygen depletion from both the rapid or immediate oxygen demand (IOD) of oxygen-demanding substances such as ferrous iron, followed by the slower microbially mediated biological oxygen demand (BOD) (Stillwater Sciences 2011). Using modeled estimates of SSC corresponding to expected river discharges during three representative water year types (see Section 3.2.5.2), the analysis of this potential impact accounts for changes in oxygen demand and river reaeration with distance (i.e., travel time of suspended sediments) to estimate corresponding dissolved oxygen concentrations in the various reaches of the Klamath River. Because prior analyses indicated that IOD and BOD are generally met at all expected SSC levels within the Klamath River (Stillwater Sciences 2011), the analysis below does not separately address potential impacts to the Pacific Ocean.

Modeled short-term oxygen demand as a function of SSC is not available for the Hydroelectric Reach. However, the results for the mainstem Klamath River downstream from Iron Gate Dam can also be applied to the Hydroelectric Reach. As a worst-case scenario, the reduction in dissolved oxygen due to short-term oxygen demand from sediment release in the Hydroelectric Reach is assumed to be the same as those for the Middle and Lower Klamath River. This is a conservative assumption because peak

SSCs downstream from J.C. Boyle Reservoir would be much lower and present for a shorter duration (2,000 to 3,000 mg/L occurring within one to two months of reservoir drawdown) than those predicted downstream from Iron Gate Dam (7,000 to 14,000 mg/L occurring within two to three months of reservoir drawdown) (Figure 3.2-11 through Figure 3.2-13). As is the case for the Middle Klamath River immediately downstream of Iron Gate Dam (see below), short-term reductions in dissolved oxygen due to release of sediment deposits within the Lower Klamath Project reservoir footprints would substantially exacerbate an existing exceedance of applicable water quality standards and therefore be a significant and unavoidable impact for the Hydroelectric Reach.

Middle and Lower Klamath River and the Klamath River Estuary

Based on results of short-term oxygen demand modeling of estimated SSCs across dam removal year 1 and 2 (see also Section 3.2.4.4), IOD downstream from Iron Gate Dam would be 0.0 to 8.6 mg/L and BOD would be 0.3 to 43.8 mg/L for all water year types considered (i.e., wet, median, dry) and for six months following initiation of reservoir drawdown (see Table 3.2-14). The highest predicted IOD and BOD levels are anticipated to occur during February of dam removal year 2, and they would correspond to the peak SSCs in the river (Figure 3.2-15 through Figure 3.2-17).

During dam removal year 1, with initial dissolved oxygen assumed to be on the order of 70 percent and 80 percent saturation in November and December, respectively, the low IOD and BOD from initial drawdown results in a less than 1 mg/L decrease in dissolved oxygen concentrations during these two months within the first mile downstream from Iron Gate Dam (Table 3.2-14), followed by gradual increases to near saturation at locations farther downstream. Under an assumption that high initial dissolved oxygen conditions persist into January through May of dam removal year 2, dissolved oxygen concentrations downstream from Iron Gate Dam would generally be greater than 5 mg/L despite the relatively high predicted IOD and BOD values (Table 3.2-14). Exceptions include predicted concentrations in February of dam removal year 1 for median (WY1976) and typical dry year (WY2001) hydrologic conditions, which exhibit minimum values of 3.5 mg/L and 1.3 mg/L, respectively. For all water year types (wet, median, dry), the predicted dissolved oxygen minimum values would occur by approximately RM 191–193.1 (approximately 0 to 2 miles downstream from Iron Gate Dam) and would return to at least 5 mg/L by approximately RM 178 to 180 (within 12 to 15 miles of the dam), or near the confluence with the Shasta River (RM 179.5).

Recognizing that IOD/BOD model results are sensitive to initial dissolved oxygen concentrations (Stillwater Sciences 2011), an additional modeling simulation was conducted to examine results assuming complete anoxia (i.e., 0 percent saturation) during dam removal year 2 (January through May) as an initial condition at Iron Gate Dam. Modeled dissolved oxygen concentrations remained below 5 mg/L downstream to RM 145 near the Scott River confluence during February of Dry Water Years, and as far downstream as RM 121.7, or 10 miles downstream of Seiad Valley (RM 132) in Normal and Wet Water Years (Table 3.2-14). At other times, dissolved oxygen concentrations generally recover before RM 134, near Seiad Valley (RM 132).

The Basin Plan water quality objective for dissolved oxygen is expressed as percent saturation (90 percent saturation). Assuming average February (2009) water temperatures, the water quality objective for November through April would range from 9.6 mg/L to 10.6 mg/L. Based on oxygen demand model results assuming high initial dissolved concentrations in dam removal year 2, recovery to the Basin Plan water quality objective of 90 percent saturation would occur generally within the reach from Seiad Valley (RM 132.7) to the mainstem confluence with Clear Creek (RM 100), or within a distance of 62 to 93 miles downstream from Iron Gate Dam for all water year types. Assuming low initial dissolved oxygen concentrations, recovery to the Basin Plan water quality objective of 90 percent saturation would occur generally farther downstream and within the reach from Clear Creek (RM 100) to the mainstem confluence with the Salmon River (RM 66), or 93 to 127 miles downstream from Iron Gate Dam for all water year types.

Thus, upstream of the Salmon River on the Middle Klamath River, short-term increases in IOD and BOD and reductions in dissolved oxygen due to release of sediments currently trapped behind the Lower Klamath Project dams would be a significant impact because reductions in dissolved oxygen below Basin Plan water quality objectives of 90 percent saturation for November through April (see also Table 3.2-5) would cause an exceedance of a water quality objective and a failure to maintain a beneficial use (COLD). Because physical removal of reservoir bottom sediments prior to drawdown is not feasible (Lynch 2011), and dam removal alternatives to the Proposed Project that would alter the timing and amount of sediment mobilization would result in the same or greater adverse impacts to designated beneficial uses and/or fish (see Section 4.1.1.4 *Elimination of Potential Alternatives that Would Not Avoid or Substantially Lessen Significant Environmental Effects of the Proposed Project*), the short-term significant impact of increased IOD and BOD and decreased dissolved oxygen in the Middle Klamath River upstream of the Salmon River cannot be avoided or substantially decreased through reasonably feasible mitigation. Because re-aeration through the water surface is sufficient to satisfy the most conservative assumptions of low initial dissolved oxygen (0 percent saturation) combined with high initial IOD and BOD (February conditions of Normal and Wet Water Year hydrology), there would be no significant impact from reduced dissolved oxygen concentrations due to sediment releases at any locations downstream of the Salmon River confluence on the Middle Klamath River, as well as in the Lower Klamath River and the Klamath River Estuary.

Table 3.2-14. Estimated Short-term Immediate Oxygen Demand (IOD) and Biochemical Oxygen Demand (BOD) by Month for Modeled Flow and SSCs Immediately Downstream from Iron Gate Dam Under the Proposed Project.

Date [1]	Boundary Conditions at Iron Gate Dam					Model Output Assuming High Initial Dissolved Oxygen[5]				Model Output Assuming Zero Initial Dissolved Oxygen[5]			
	Flow (cfs)[2]	SSC (mg/L)[3]	IOD (mg/L)	BOD (mg/L)	Avg. Temperature (deg C)[4]	Initial Dissolved Oxygen Downstream of Iron Gate Dam (mg/L)[6]	Minimum Dissolved Oxygen (mg/L)	Location of Minimum Dissolved Oxygen (RM)[7]	Modeled Location at Which Dissolved Oxygen Returns to 5 mg/L (RM)[7]	Initial Dissolved Oxygen Downstream of Iron Gate Dam (mg/L)[6]	Minimum Dissolved Oxygen (mg/L)	Location of Minimum Dissolved Oxygen (RM)[7]	Modeled Location at Which Dissolved Oxygen Returns to 5 mg/L (RM)[7]
Typical Wet Hydrology (WY 1984 Conditions Assumed)													
11/30	3,343	444	0.3	1.6	9.9	7.3	7.1	192.5	NA[8]	7.3	7.1	192.5	NA[8]
12/1	7,139	430	0.3	1.5	5	9.4	9.2	191.9	NA[8]	9.4	9.2	191.9	NA[8]
1/21	8,675	1,962	1.2	6.9	3.7	9.7	8.6	191.2	NA[8]	0.0	0.0	193.1	172.7
2/15	3,949	7,116	4.5	25.1	4.4	9.6	5.2	191.9	NA[8]	0.0	0.0	193.1	121.7
3/1	4,753	593	0.4	2.1	6.7	9.0	8.7	191.9	NA[8]	0.0	0.0	193.1	182.6
4/15	4,374	939	0.6	3.3	8.4	8.6	8.1	191.9	NA[8]	0.0	0.0	193.1	166.5
5/15	4,169	711	0.4	1.5	17.4	7.0	6.7	192.5	NA[8]	0.0	0.0	193.1	134.2
Median Hydrology (WY 1976 Conditions Assumed)													
11/30	2,074	96	0.1	0.3	9.9	7.3	7.3	193.1	NA[8]	7.3	7.1	193.1	NA[8]
12/1	2,156	203	0.1	0.7	5	9.4	9.3	192.5	NA[8]	9.4	9.2	192.5	NA[8]
1/21	6,533	2,594	1.6	9.1	3.7	9.7	8.2	191.2	NA[8]	0.0	0.0	193.1	164.6
2/15	2,933	9,893	6.2	34.8	4.4	9.6	3.5	191.9	178.2	0.0	0.0	193.1	121.7
3/1	3,016	1,461	0.9	5.1	6.7	9.0	8.2	191.9	NA[8]	0.0	0.0	193.1	176.4
4/15	2,657	509	0.3	1.8	8.4	8.6	8.4	191.9	NA[8]	0.0	0.0	193.1	179.5
5/15	2,355	191	0.1	0.7	17.4	7.0	7.0	192.5	NA[8]	0.0	0.0	193.1	155.3

Date [1]	Boundary Conditions at Iron Gate Dam					Model Output Assuming High Initial Dissolved Oxygen[5]				Model Output Assuming Zero Initial Dissolved Oxygen[5]			
	Flow (cfs)[2]	SSC (mg/L)[3]	IOD (mg/L)	BOD (mg/L)	Avg. Temperature (deg C)[4]	Initial Dissolved Oxygen Downstream of Iron Gate Dam (mg/L)[6]	Minimum Dissolved Oxygen (mg/L)	Location of Minimum Dissolved Oxygen (RM)[7]	Modeled Location at Which Dissolved Oxygen Returns to 5 mg/L (RM)[7]	Initial Dissolved Oxygen Downstream of Iron Gate Dam (mg/L)[6]	Minimum Dissolved Oxygen (mg/L)	Location of Minimum Dissolved Oxygen (RM)[7]	Modeled Location at Which Dissolved Oxygen Returns to 5 mg/L (RM)[7]
Typical Dry Hydrology (WY 2001 Conditions Assumed)													
11/30	1,141	79	0	0.3	9.9	7.3	7.3	193.1	NA[8]	7.3	7.1	193.1	NA[8]
12/1	1,284	122	0.1	0.4	5	9.4	9.4	193.1	NA[8]	9.4	9.2	193.1	NA[8]
1/21	4,245	3,514	2.2	12.4	3.7	9.7	7.6	191.2	NA[8]	0.0	0.0	193.1	158.4
2/15	1,040	13,574	8.6	47.8	4.4	9.6	1.3	191.9	180.1	0.0	0.0	193.1	144.7
3/1	1,344	2,421	1.5	8.5	6.7	9.0	7.6	191.9	NA[8]	0.0	0.0	193.1	178.9
4/15	1,150	551	0.3	1.9	8.4	8.6	8.4	191.9	NA[8]	0.0	0.0	193.1	185.1
5/15	1,143	296	0.2	1.0	17.4	7.0	7.0	192.5	NA[8]	0.0	0.0	193.1	172.7

Source: Stillwater Sciences 2011

[1] Dam removal year 1 is represented by November and December, with dam removal year 2 represented by January through May.

[2] Predicted daily flow values from USBR hydrologic model output (USBR 2012). Daily flow values correspond to the peak suspended sediment concentration (SSC) for each month.

[3] Predicted peak suspended sediment concentration (SSC) by month from USBR model output (USBR 2012)

[4] Raw daily water temperature data for 2009 from http://www.pacificorp.com/es/hydro/hl/kr.html# (PacifiCorp 2009).

[5] Assumes 70% and 80% saturation during November and December of dam removal year 1, respectively, with either high (80%) or low (0%) initial dissolved oxygen during January through May of dam removal year 2

[6] Initial dissolved oxygen concentration downstream from Iron Gate Dam was calculated using average monthly water temperature, salinity = 0 ppt, and elevation = 707 m (2,320 ft).

[7] River miles (RM) listed are those used in Stillwater Sciences (2011). The river miles listed are different from those used in this EIR, because the river miles have been updated since 2011 based on slight changes in the river path.

[8] NA = not applicable because dissolved oxygen consistently remains greater than 5 mg/L at all locations downstream of Iron Gate Dam.

The Definite Plan (see Appendix B: *Definite Plan – Appendix M*) includes a Water Quality Monitoring Plan to assess the Proposed Project's impacts to water quality, and this plan includes turbidity and suspended sediment concentration monitoring along with adaptive management requirements. Please note that the State Water Board has authority to review and approve any final Water Quality Monitoring Plan through its water quality certification under Clean Water Act Section 401. The State Water Board has issued a draft water quality certification[58] which sets forth water quality monitoring, adaptive management, and compliance requirements for any Water Quality Monitoring Plan to meet, as Condition 1 *Water Quality Monitoring and Adaptive Management* and Condition 2 *Compliance Schedule.* Condition 2 acknowledges that the Proposed Project would have temporary (short-term) exceedances of water quality objectives associated with reservoir drawdown and the export of reservoir sediments into the Klamath River and Pacific Ocean. Restoration projects may cause exceedances of water quality objectives in the short term in light of the long-term water quality and ecosystem benefits they provide. Additionally, the Oregon Department of Environmental Quality has issued a water quality certification[59] that sets forth water quality monitoring and adaptive management conditions for points upstream of California, including an assessment of baseline river conditions upstream of dam removal operations.

Significance

Significant and unavoidable in the short term for Hydroelectric Reach and Middle Klamath River from Iron Gate Dam to the Salmon River

No significant impact in the short term for the Middle Klamath River downstream from the Salmon River, in the Lower Klamath River, or in the Klamath River Estuary

Potential Impact 3.2-10 Long-term alterations in dissolved oxygen concentrations and daily variability due to conversion of the reservoir areas to a free-flowing river.

Hydroelectric Reach

Modeling conducted for development of the Klamath River TMDLs indicates that in the long term under the "TMDL dams-out" scenario for Oregon reaches (TOD2RN), average dissolved oxygen concentrations in the Hydroelectric Reach downstream of J.C. Boyle Dam and at the Oregon-California state line would be the same or slightly greater during July through October than those under the "TMDL dams-in" scenario (T4BSRN) (North Coast Regional Board 2010). The same pattern is predicted for 30-day mean minimum and 7-day mean minimum dissolved oxygen criteria. With respect to daily variability in dissolved oxygen, the Klamath River TMDL model predicts somewhat reduced variability under the "TMDL dams-out" scenario for California reaches (TCD2RN) as compared to the "TMDL dams-in" scenario (T4BSRN) (Figure 3.2-19). The predicted decreases in daily variability at the Oregon-California state line may be due to elimination of hydropower peaking operations; however, since daily variability in dissolved oxygen is not currently an issue in the J.C. Boyle Peaking Reach, slightly reducing this variability would not be considered a beneficial effect.

[58] The State Water Board's draft water quality certification is available at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 14, 2018).

[59] The Oregon Department of Environmental Quality's final water quality certification is available at: https://www.oregon.gov/deq/FilterDocs/ferc14803final.pdf (Accessed December 14, 2018).

For the free-flowing reaches of the river replacing Copco No. 1 and Iron Gate reservoirs, long-term dissolved oxygen levels in the river would differ substantially from the super-saturation (i.e., greater than 100 percent saturation) that currently occurs in surface waters and the hypolimnetic oxygen depletion in that occurs in bottom waters of the reservoirs during the April/May through October/November period (see Section 3.2.2.5 *Dissolved Oxygen*). Dissolved oxygen in the free-flowing reaches of the river replacing the reservoirs would not exhibit such extremes and would instead show the typical dissolved oxygen concentrations of a flowing river. Long-term increases in summer and fall dissolved oxygen would be beneficial. Long-term dissolved oxygen levels or variability during winter and spring would not be significantly different under the Proposed Project compared to existing conditions, so the Proposed Project would not have the potential to cause or substantially exacerbate an exceedance of water quality standards or result in a failure to maintain existing beneficial uses currently supported, and would therefore have a less than significant impact on winter and spring dissolved oxygen concentrations for the Hydroelectric Reach.

Note that the Klamath River TMDL model scenarios are useful for informing impacts associated with the Proposed Project and alternatives identified in Section 4 *Alternatives*, but they include as a starting assumption that there will be full implementation of the TMDLs. For example, the "TMDL dams-in" (T4BSRN) and "TMDL dams-out" (TOD2RN) scenarios for California both assume that water entering into California from Oregon meets California water quality standards for water temperature, organic enrichment/low dissolved oxygen, nutrients, pH, and microcystin. In other words, the starting point for the California models is that all necessary reductions in pollution to address the current impaired conditions at the Oregon-California state line for these constituents would already have been implemented upstream. The full TMDL compliance modeling assumption does not reflect the existing conditions, and it would be speculative at this point to identify either the mechanisms necessary to implement the TMDLs or the timing required to achieve full compliance. However, the dissolved oxygen mechanism modeled in the Klamath River TMDLs would be the same even if model inputs for dissolved oxygen were changed to concentrations under existing conditions, such that the general trend indicated by the Klamath River TMDL model output (i.e., dam removal would eliminate the seasonal thermal stratification and phytoplankton bloom patterns that occur in the reservoirs under existing conditions and affect dissolved oxygen) is still informative for conditions where full TMDL compliance has not occurred.

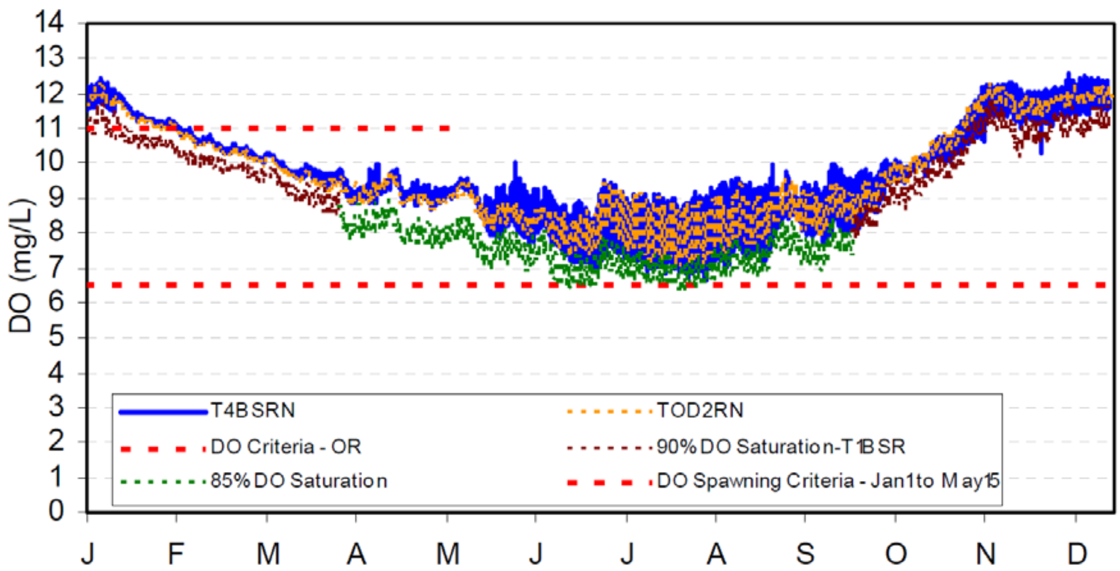

Figure 3.2-19. Predicted Dissolved Oxygen at the Oregon-California State Line (RM 214.1) for the Klamath River TMDL Scenarios Similar to the Proposed Project ("TMDL dams-out, Oregon" [TOD2RN] Scenario) and Existing Conditions ("TMDL dams-in" [T4BSRN] Scenario). Source: North Coast Regional Board 2010.

Middle and Lower Klamath River, Klamath River Estuary, and Pacific Ocean Nearshore Environment

KRWQM results using 2001 to 2004 data indicate that substantial improvements in long-term dissolved oxygen may occur immediately downstream from Iron Gate Dam if the Lower Klamath Project dams are removed, with increases of three to four mg/L possible during summer and late fall (PacifiCorp 2005). KRWQM output also predicts greater daily variations in dissolved oxygen concentrations downstream from Iron Gate Dam to the Trinity River confluence (RM 43.3) in the absence of the Lower Klamath Project dams, based upon the assumption that periphyton growth would occur in this reach if the dams were removed and would increase daily dissolved oxygen fluctuations due to photosynthetic oxygen production and respiratory consumption. However, the KRWQM does not include nutrient retention in the mainstem river downstream from Iron Gate Dam and assumes relatively high nutrient contributions from tributaries (Asarian and Kann 2006b). These input assumptions lead to a likely overestimate of the increase in periphyton growth, and therefore a likely overestimate of modeled predicted daily variations in dissolved oxygen.

Like the KRWQM model, the Klamath River TMDL model (see Appendix D) also indicates that under the "TMDL dams-out" scenario for California reaches (TCD2RN), long-term dissolved oxygen concentrations immediately downstream from Iron Gate Dam during July through November would be greater than those under the "TMDL dams-in" scenario (T4BSRN), due to the lack of stratification and oxygen depletion in bottom waters in the upstream reservoirs as compared with a free-flowing river condition (see Figure 3.2-20). Although the Klamath River TMDL model assumes full TMDL compliance (see below discussion regarding applicability of this assumption for analysis of the Proposed Project), the "TMDL dams-in" scenario (T4BSRN) results follow the same basic trend as existing conditions dissolved oxygen concentrations immediately downstream of Iron Gate Dam, where concentrations regularly fall below 8.0 mg/L and the Basin Plan minimum dissolved oxygen criteria of 85 to 90 percent saturation (depending on season) (see also Section 3.2.2.5 *Dissolved Oxygen*). Under existing conditions, low dissolved oxygen concentrations during late summer and fall continue to occur immediately downstream of Iron Gate Dam despite ongoing turbine venting at the Iron Gate Powerhouse required under KHSA Interim Measure 3.

The Klamath River TMDL model also predicts that daily fluctuations in dissolved oxygen immediately downstream of Iron Gate Dam during June through October would be greater under the "TMDL dams-out" scenario for California reaches (TCD2RN) than the "TMDL dams-in" scenario (T4BSRN) (Figure 3.2-20), a condition potentially linked to periphyton establishment in the free-flowing reaches of the river that are currently occupied by reservoirs, and associated daily swings in photosynthetic oxygen production and respiratory consumption. Again, although the Klamath River TMDL model assumes full TMDL compliance (see below discussion regarding applicability of this assumption for analysis of the Proposed Project), the "TMDL dams-in" scenario (T4BSRN) results follow the same basic trend as existing conditions dissolved oxygen percent saturation immediately downstream of Iron Gate Dam, where concentrations regularly fall below the Basin Plan minimum dissolved oxygen criteria of 85 – 90 percent saturation during June through October (see also Section 3.2.2.5 *Dissolved Oxygen*).

Differences in long-term dissolved oxygen concentrations and percent saturation between the "TMDL dams-out" scenario and the "TMDL dams-in" scenario diminish with distance downstream from Iron Gate Dam, with similar or the same predicted dissolved oxygen concentrations and similar magnitude and duration of daily fluctuations by Seiad Valley (RM 132.7) and no differences by the confluence with the Trinity River (RM 43.3) (see Figure 3.2-20 to Figure 3.2-23). The Klamath River TMDL model trends are consistent with existing conditions for this reach (see also Section 3.2.2.5 *Dissolved Oxygen*).

At all modeled locations, the Klamath River TMDL model indicates consistent compliance with the Basin Plan water quality objective of 85 percent saturation (see Figure 3.2-20 to Figure 3.2-23). Further downstream, near the confluence with the Trinity River (see Figure 3.2-23), results also indicate that while minimum values may occasionally dip below the current Hoopa Valley Tribe minimum water quality objective (8 mg/L, applicable at approximately RM 45), they would not fall below the 85 percent saturation objective modeled for the TMDL and would likely also not fall below the 90 percent saturation[60] Hoopa Valley Tribe objective[61]. Winter time (January through March) dissolved oxygen concentrations would be slightly lower under the Proposed Project but would not fall below Basin Plan minimum criteria for the winter season (90 percent saturation). The Klamath River TMDL model trends are consistent with existing conditions for this reach (see also Section 3.2.2.5 *Dissolved Oxygen*).

Note that the Klamath River TMDL model scenarios are useful for informing impacts associated with the Proposed Project and alternatives identified in Section 4 *Alternatives*, but they include as a starting assumption that there will be full

[60] This objective is not shown in Figure 3.2-23, but the general trend for 90 percent saturation can be estimated from the 85 percent saturation shown in the figure.
[61] As noted, there is no difference between the "TMDL dams-in" and "TMDL dams-out" scenarios by the confluence with the Trinity River where the Hoopa Valley Tribe's water quality standards are applicable.

implementation of the TMDLs. For example, the "TMDL dams-in" (T4BSRN) and "TMDL dams-out" (TOD2RN) scenarios for California both assume that water entering into California from Oregon meets California water quality standards for water temperature, organic enrichment/low dissolved oxygen, nutrients, pH, and microcystin. In other words, the starting point for the California models is that all necessary reductions in pollution to address the current impaired conditions at the Oregon-California state line for these constituents would already have been implemented upstream. The full TMDL compliance modeling assumption does not reflect the existing condition, and it would be speculative at this point to identify either the mechanisms necessary to implement the TMDLs or the timing required to achieve full compliance. However, the dissolved oxygen mechanism modeled in the Klamath River TMDLs would be the same even if model inputs for dissolved oxygen were changed to concentrations under existing conditions, such that the general trend indicated by the Klamath River TMDL model output (i.e., dam removal would eliminate the seasonal thermal stratification and phytoplankton bloom patterns that occur in the reservoirs under existing conditions and affect dissolved oxygen) is still informative for conditions where full TMDL compliance has not occurred.

Under the Proposed Project, the magnitude of the increased daily fluctuations in dissolved oxygen immediately downstream from Iron Gate Dam predicted by the PacifiCorp and Klamath River TMDL modeling efforts contain some uncertainty since the role of photosynthesis and community respiration from periphyton growth in the free-flowing reaches of the river that would replace the reservoirs at the Lower Klamath Project is unknown because nutrient cycling and resulting rates of primary productivity under modeled existing conditions are uncertain (see Section 3.4 *Phytoplankton and Periphyton*). Although the magnitude of the increased variability is somewhat uncertain, the overall daily fluctuations in dissolved oxygen are expected to increase in the Middle Klamath River from immediately downstream of Iron Gate Dam to Seiad Valley under the Proposed Project, especially during summer and fall. Even with the increase in daily fluctuations, the dissolved oxygen concentrations from immediately downstream of Iron Gate Dam to Seiad Valley would remain above Basin Plan dissolved oxygen saturation objectives throughout the year, so the Proposed Project would have a less than significant impact on dissolved oxygen in the long term. Downstream of Seiad Valley, the daily fluctuations in dissolved oxygen under the Proposed Project would be similar to existing conditions with the dams and the Proposed Project would have no impact. In addition to the increase in daily fluctuations, the removal of the Lower Klamath Project under the Proposed Project would cause beneficial long-term increases in summer and fall dissolved oxygen in the Middle Klamath River immediately downstream from Iron Gate Dam. Long-term decreases in winter and spring dissolved oxygen in the Middle Klamath River would be less than significant since the dissolved oxygen concentration would remain above Basin Plan dissolved oxygen saturation objectives. Effects would diminish with distance downstream from Iron Gate Dam, such that there would be no measurable impacts on dissolved oxygen by transition to the Lower Klamath River (i.e., the confluence with the Trinity River) and no impacts to the Klamath River Estuary or the Pacific Ocean nearshore environment.

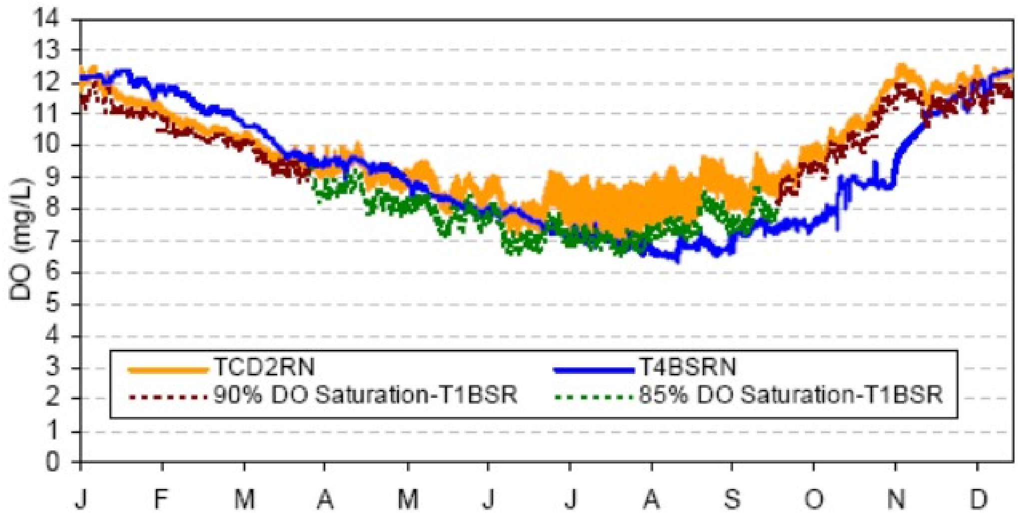

Figure 3.2-20. Predicted Dissolved Oxygen Downstream from Iron Gate Dam for the Klamath River TMDL Scenarios Similar to the Proposed Project ("TMDL dams-out, Oregon" [TOD2RN] Scenario) and Existing Conditions ("TMDL dams-in" [T4BSRN] Scenario). Source: North Coast Regional Board 2010.

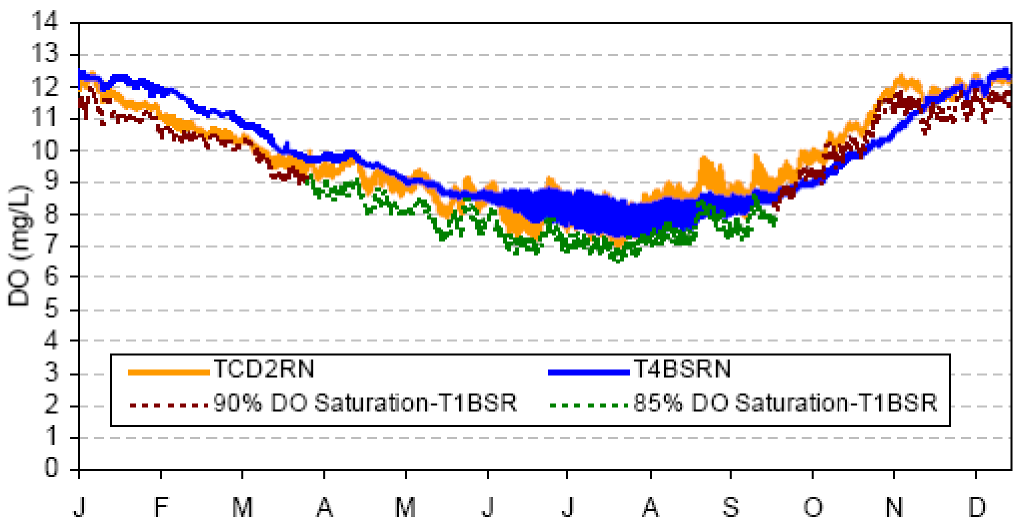

Figure 3.2-21. Predicted Dissolved Oxygen Downstream from the Mainstem Confluence with the Shasta River (RM 179.5) for the Klamath River TMDL Scenarios Similar to the Proposed Project ("TMDL dams-out, Oregon" [TOD2RN] Scenario) and Existing Conditions ("TMDL dams-in" [T4BSRN] Scenario). Source: North Coast Regional Board 2010.

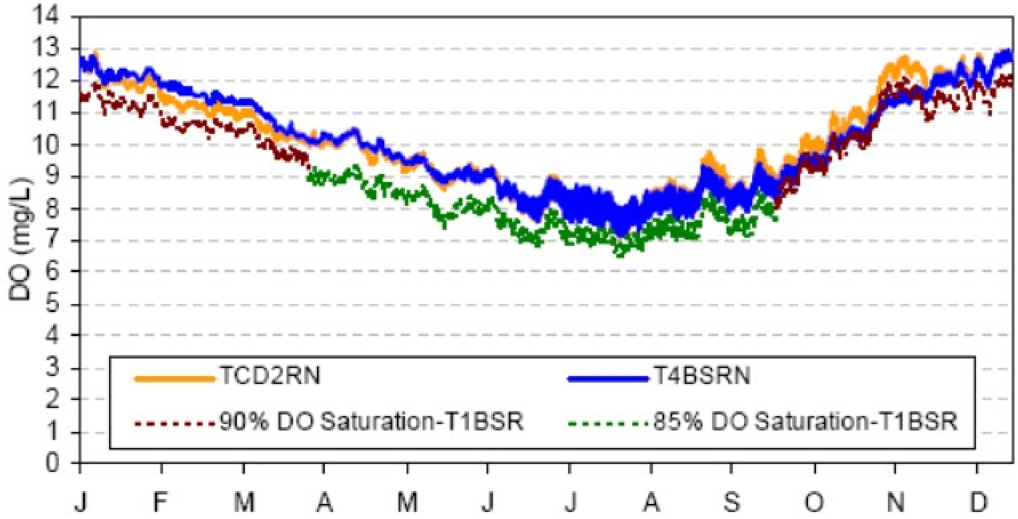

Figure 3.2-22. Predicted Dissolved Oxygen at Seiad Valley (RM 132.7) for the Klamath River TMDL Scenarios Similar to the Proposed Project ("TMDL dams-out, Oregon" [TOD2RN] Scenario) and Existing Conditions ("TMDL dams-in" [T4BSRN] Scenario). Source: North Coast Regional Board 2010.

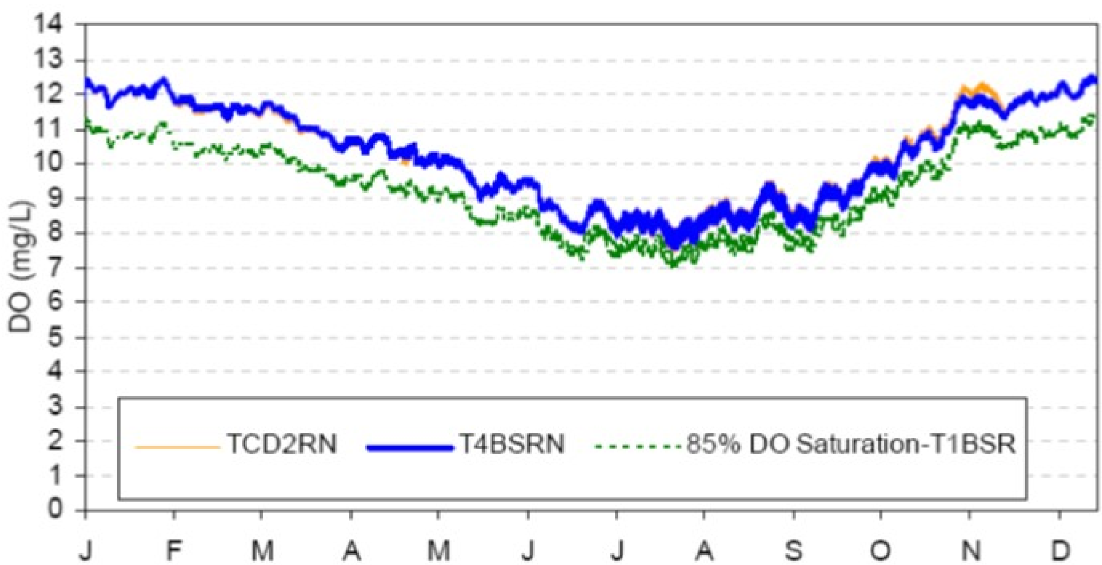

Figure 3.2-23. Predicted Dissolved Oxygen Just Upstream of the Confluence with the Trinity River (RM 43.3) for the Klamath River TMDL Scenarios Similar to the Proposed Project ("TMDL dams-out, Oregon" [TOD2RN] Scenario) and Existing Conditions ("TMDL dams-in" [T4BSRN] Scenario). Source: North Coast Regional Board 2010.

Significance

No significant impact for daily fluctuations in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam

Beneficial for elimination of summer and fall extremes in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam

No significant impact for winter and spring concentrations in the Hydroelectric Reach and Middle Klamath River

No significant impact in the Lower Klamath River, Klamath River Estuary, and Pacific Ocean nearshore environment

3.2.5.5 pH

Potential Impact 3.2-11 Alterations in pH and daily pH fluctuations due to a conversion of the reservoir areas to a free-flowing river.

Surface water pH in the water quality Area of Analysis may be affected by changes in the amount of photosynthesis occurring during the summer and fall in the Klamath River. Conversion of the reservoir areas to a free-flowing river would change the available habitat for phytoplankton and/or periphyton, and changes in the growth patterns of these organisms would then change overall pH levels and variability in pH over a diel cycle (i.e., 24-hour period). The Hoopa Valley Tribe water quality objective for pH (7.0–8.5) is met the vast majority of the time under the Proposed Project (similar to the TMDL dams-out" [TCD2RN] scenario) for the Middle Klamath River at the reach of Hoopa jurisdiction (approximately RM 45), with a small number of predicted pH values of approximately 8.6 in summer months (July and August).

Hydroelectric Reach

While the Hydroelectric Reach is not currently identified as being impaired for pH specifically and the California Klamath River TMDLs do not include specific allocations or targets for pH itself, pH is identified as a secondary indicator of biostimulation, and pH impacts (i.e., exceedances of Basin Plan numeric pH objectives, see Table 3.2-3) are closely related to excessive nutrient inputs to the Klamath River (North Coast Regional Board 2010). pH values in Copco No. 1 and Iron Gate reservoirs can exceed the Basin Plan instantaneous maximum pH objective of 8.5 s.u., with large (0.5 to 1.5 s.u.) daily fluctuations occurring in reservoir surface waters during summertime periods of intense phytoplankton blooms (see Section 3.2.2.6 *pH*).

Modeling of pH conducted for development of the Klamath River TMDLs (Kirk et al. 2010, North Coast Regional Board 2010) provides information applicable to the assessment of long-term impacts of the Proposed Project on pH levels in the Hydroelectric Reach. Klamath River TMDL model results indicate that under the "TMDL dams-out" scenario for Oregon reaches (TOD2RN), pH at the Oregon-California state line would exhibit less daily variability during spring (March to May) and fall (October to November) (see Figure 3.2-24) than the "TMDL dams-in" scenario (T4BSRN). Daily variability in river pH during the summertime (June to September) would be similar or somewhat greater under the "TMDL dams-out" scenario (TOD2RN) than the "TMDL dams-in" scenario (T4BSRN), with the slight increase likely due to periphyton growth in the free-flowing river reaches currently occupied by the upstream J.C. Boyle Reservoir and the cessation of hydropower peaking flows in the Peaking Reach that may play a role in preventing establishment of mats under existing conditions. The "TMDL dams-out" scenario (TOD2RN) model results at the Oregon-California state line would occasionally exceed 8.5 s.u. However, because the frequency of exceeding 8.5 s.u. under the "TMDL dams-out" scenario (TOD2RN) would generally be the same as under existing conditions, removal of the Lower Klamath Project dams under the Proposed Project would not result in a failure to meet the instantaneous maximum pH objective at the levels currently supported in either the short term or the long term and there would be no significant impact.

Note that the Klamath River TMDL model scenarios are useful for informing impacts associated with the Proposed Project and alternatives identified in Section 4 *Alternatives*, but they include as a starting assumption that there will be full implementation of the TMDLs. For example, the "TMDL dams-in" (T4BSRN) and "TMDL dams-out" (TOD2RN) scenarios for California both assume that water entering into California from Oregon meets California water quality standards for water temperature, organic enrichment/low dissolved oxygen, nutrients, pH, and microcystin. In other words, the starting point for the California models is that all necessary reductions in pollution to address the current impaired conditions at the Oregon-California state line for these constituents would already have been implemented upstream. The full TMDL compliance modeling assumption does not reflect the existing condition, and it would be speculative at this point to identify either the mechanisms necessary to implement the TMDLs or the timing required to achieve full compliance. Further, the changes in daily fluctuations for pH indicated by the Klamath River TMDL modeling efforts are not entirely certain because growth rates of periphyton (attached algae) that could influence pH through photosynthesis in the free-flowing reaches of the river replacing Copco No. 1 and Iron Gate reservoirs are not precisely known. However, because modeled pH peak values and daily variability would be influenced by increasing nutrient concentrations in both the "TMDL dams-in" (T4BSRN) (from phytoplankton growth in reservoirs) and "TMDL dams-out" (TOD2RN) (from periphyton growth in river reaches) scenarios, the comparative model output is still informative with respect to general trends under conditions where full TMDL compliance has not occurred.

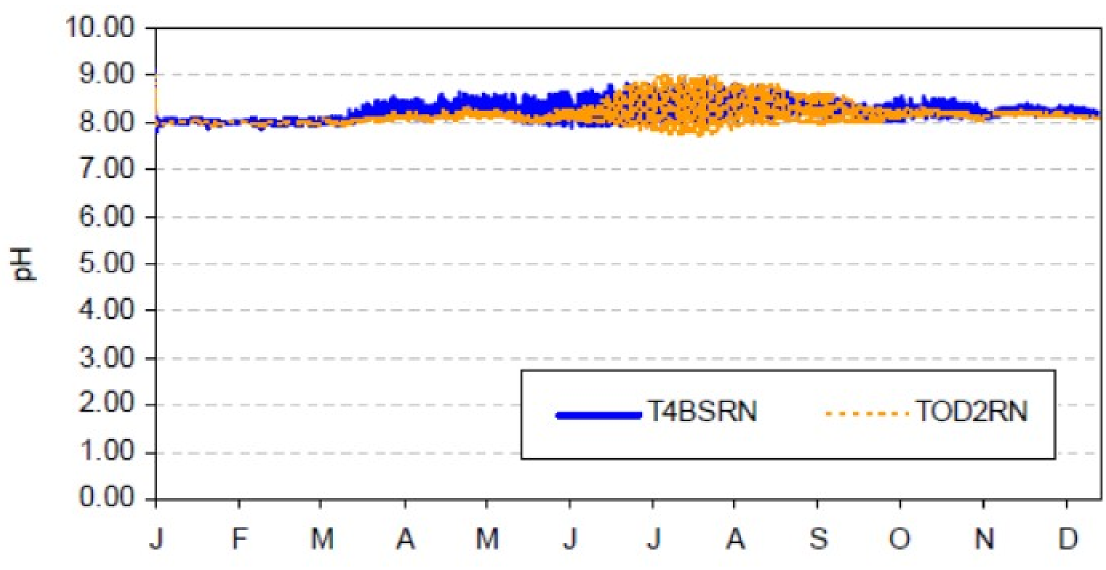

Figure 3.2-24. Predicted pH at the Oregon-California State Line (RM 214.1) for the Klamath River TMDL Scenarios Similar to the Proposed Project (TOD2RN Scenario) and the modeled existing conditions (T4BSRN Scenario). Source: North Coast Regional Board 2010.

The Proposed Project also would be expected to eliminate the occurrence of high pH (greater than 8.5 s.u.) and large daily fluctuations (0.5–1.5 s.u.) that occur in the surface waters of Copco No. 1 and Iron Gate reservoirs under existing conditions during periods of intense phytoplankton blooms (see Section 3.2.2.6 *pH*). The pH in the free-flowing reaches of the river replacing these reservoirs would not be likely to exhibit such extremes in daily pH and would not result in a failure to meet the existing instantaneous maximum pH objective at the levels currently supported and would be beneficial.

These beneficial pH changes, which would result from the conversion from a reservoir to a riverine system, would occur immediately following dam removal, in the spring of dam removal year 2. In contrast, the potential for the river reaches that replace Copco No. 1 and Iron Gate reservoirs to support periphyton growth along the river bed that increases variability in daily pH and potentially results in elevated pH values would be constrained in the short term because high SSCs and scour along the newly mobilized river bed during the winter and spring of dam removal year 2, and potentially also post-dam removal year 1, would limit establishment of extensive periphyton mats. Overall, in the short term, the Proposed Project would not result in a failure to meet the instantaneous maximum pH objective relative to the existing conditions in the reservoirs and would be beneficial.

In summary, based on Klamath River TMDL model results, dam removal under the Proposed Project would result in a similar frequency of exceeding 8.5 s.u. as existing conditions at the Oregon-California state line, and thus there would be no significant impact the short term and the long term. The decrease in high summertime daily pH fluctuations in the free-flowing reaches of the river that replace Copco No. 1 and Iron Gate reservoirs in the Hydroelectric Reach would not result in a failure to meet the instantaneous maximum pH objective at the levels currently supported and would be beneficial in the short term.

Middle and Lower Klamath River, Klamath River Estuary, and Pacific Ocean nearshore environment

Modeling of pH conducted for the development of the California Klamath River TMDLs also provides information applicable to the assessment of long-term impacts of the Proposed Project on pH in the Middle and Lower Klamath River. In general, results from the Klamath River TMDL model (see Appendix D) indicate that the “TMDL dams-out” (TCD2RN) scenario for California would result in relatively large daily variations in pH and generally high pH levels during summer and fall in the Middle Klamath River downstream from Iron Gate Dam (Figure 3.2-25); this pattern is characteristic of periphyton growth in river reaches. Although this condition would be in contrast to the “TMDL dams-in” (T4BSRN) scenario, where the Klamath River TMDL model predicts relatively low daily variation in pH in summer and fall (Figure 3.2-25), the higher daily pH variation and overall pH levels indicated for the “TMDL dams-out” (TCD2RN) scenario downstream from Iron Gate Dam are very similar to those under existing conditions (see Section 3.2.2.6 *pH*). This indicates that dam removal under the Proposed Project would not result in a failure to meet the instantaneous maximum pH objective relative to the levels currently supported downstream from Iron Gate Dam and there would be no significant impact.

Note that while the Klamath River TMDL model scenarios are useful for informing impacts associated with the Proposed Project and alternatives identified in Section 4 *Alternatives*, they include as a starting assumption that there will be full implementation of the TMDLs. For example, the "TMDL dams-in" (T4BSRN) and "TMDL dams-out" (TOD2RN) scenarios for California both assume that water entering into California from Oregon meets California water quality standards for water temperature, organic enrichment/low dissolved oxygen, nutrients, pH, and microcystin. In other words, the starting point for the California models is that all necessary reductions in pollution to address the current impaired conditions at the Oregon-California state line for these constituents would already have been implemented upstream. Although the "TMDL dams-out" (TCD2RN) scenario downstream of iron Gate Dam produces predicted pH values that are very similar to existing conditions, the full TMDL compliance modeling assumption does not, in fact, reflect the existing condition, particularly within the existing reservoirs. As described in Section 3.2.2.6 *pH,* the reservoirs are characterized by high daily variability and pH values that exceed 8.5 s.u. on a seasonal basis due to large phytoplankton blooms in summer and fall. Because the "TMDL dams-in" (T4BSRN) scenario shown in Figure 3.2-26 represents full compliance, it also displays evidence of limited phytoplankton production in the upstream reservoirs and hence lower pH peak values and daily variability as compared with existing conditions.

In general, because the changes in daily fluctuations for pH indicated by the Klamath River TMDL modeling efforts are not entirely certain, growth rates of periphyton (attached algae) that could influence pH through photosynthesis in the Middle and Lower Klamath River are not precisely known. However, because modeled pH peak values and daily variability would be influenced by increasing nutrient concentrations in both the "TMDL dams-in" (T4BSRN) (from phytoplankton growth in reservoirs) and "TMDL dams-out" (TCD2RN) (from periphyton growth in river reaches) scenarios, the comparative model output is still informative with respect to general trends under conditions where full TMDL compliance has not occurred.

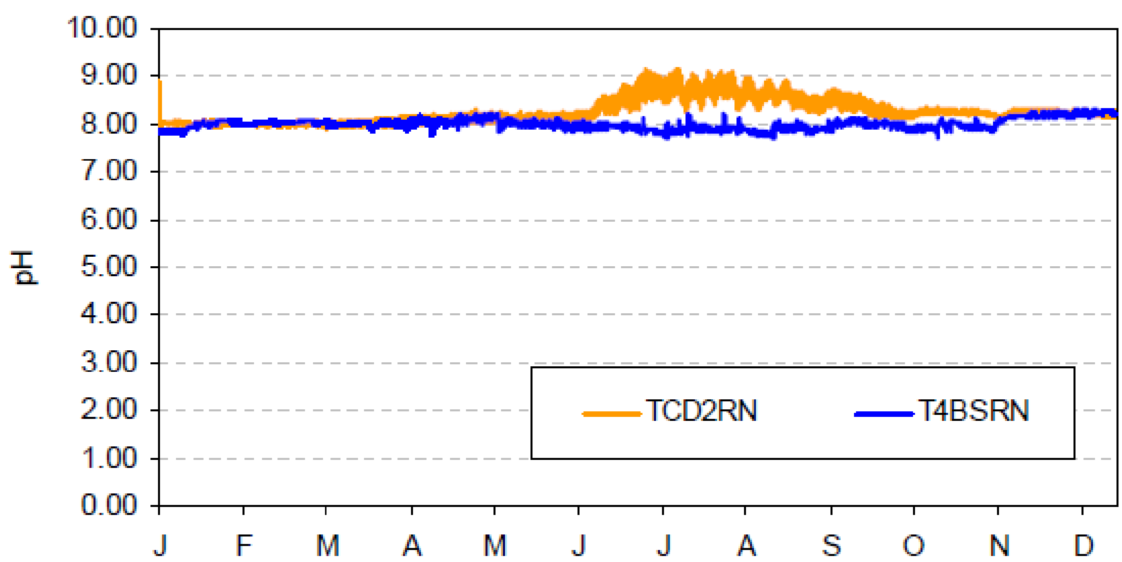

Figure 3.2-25. Predicted Klamath River pH Immediately Downstream from Iron Gate Dam for the Klamath River TMDL Scenarios Similar to the Proposed Project (TCD2RN Scenario) and the No Project Alternative (T4BSRN Scenario). Source: North Coast Regional Board 2010.

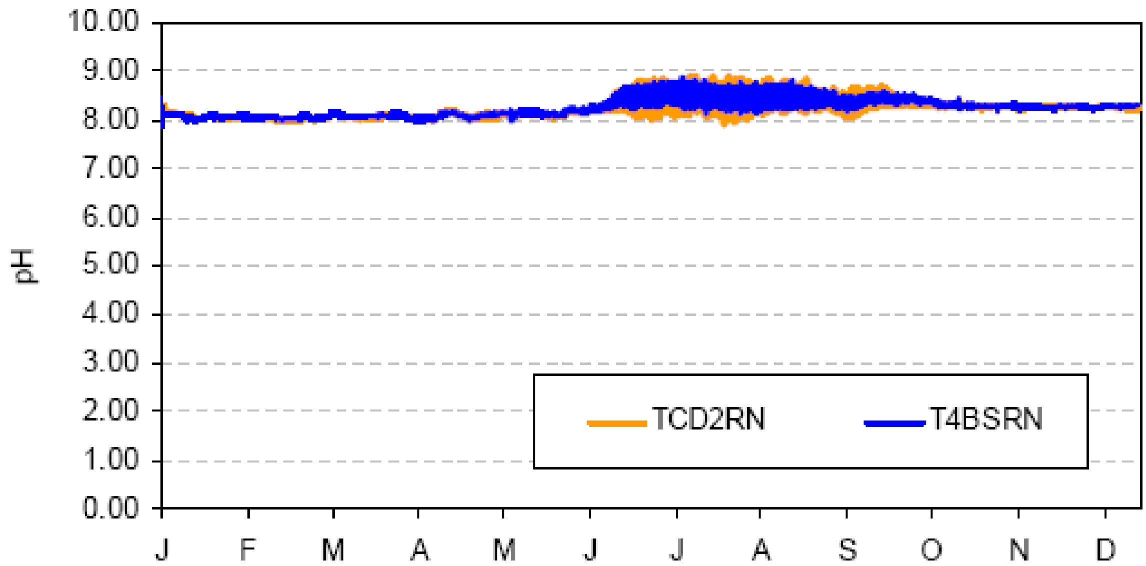

Figure 3.2-26. Predicted Klamath River pH upstream of the Scott River (RM 145.1) for the Klamath River TMDL Scenarios Similar to the Proposed Project (TCD2RN Scenario) and the No Project Alternative (T4BSRN Scenario). Source: North Coast Regional Board 2010.

As discussed above, the Proposed Project also would be expected to eliminate the occurrence of high pH (greater than 8.5 s.u.) and large daily fluctuations (0.5–1.5 s.u.) that occur in the surface waters of Copco No. 1 and Iron Gate reservoirs under existing conditions during periods of intense phytoplankton blooms, where the blooms can be transported downstream into the Middle Klamath River and adversely affect pH (see Section 3.2.2.6 *pH*). Consequently, under the Proposed Project pH in the Middle Klamath River immediately downstream of Iron Gate Reservoir would not be likely to exhibit extremes in daily pH due to seasonal phytoplankton blooms, which would reduce the potential for a failure to meet the instantaneous maximum pH objective at the levels currently supported and would be beneficial in the long term.

Klamath River TMDL modeling indicates that the Hoopa Valley Tribe water quality objective for pH (7.0–8.5) would be met the vast majority of the time under the Proposed Project (similar to the TMDL dams-out" [TCD2RN] scenario) for the Middle Klamath River at the reach of Hoopa jurisdiction (approximately RM 45), with a small number of predicted pH values of 8.5 or 8.6 in July and August. The Yurok Tribe water quality objective for pH (6.5–8.5) would be met at all times under the "TMDL dams-out" (TCD2RN) scenario for the Middle Klamath River at the reach of Hoopa jurisdiction (approximately RM 45). This suggests that dam removal under the Proposed Project would not increase the potential for exceedance of the instantaneous maximum pH objective relative to the existing conditions downstream from Iron Gate Dam.

While Klamath River TMDL modeling contains uncertainty about the periphyton response to dam removal within the Hydroelectric Reach and it assumes full TMDL compliance (see above discussion), monitoring data at multiple locations further downstream in the Middle and Lower Klamath River indicate that pH patterns over a 24-hour period are driven primarily by photosynthesis and respiration of periphyton (Ward and Armstrong 2010; Asarian et al. 2015; see Section 3.4.2.2 *Periphyton*) rather than phytoplankton. Since N-fixing species dominate the periphyton communities in the lower portions of the Middle Klamath River as well as the Lower Klamath River where inorganic nitrogen concentrations are low (Asarian et al. 2010, 2014, 2015), changes in nutrients due to dam removal are not expected to alter the periphyton community in these reaches (see Potential Impact 3.4-5). Thus, there is no evidence to indicate that there would be a change in pH relative to existing conditions that would have the potential to cause or substantially exacerbate an exceedance of water quality standards or result in a failure to maintain existing beneficial uses currently supported in these periphyton-dominated reaches, the downstream Klamath River Estuary, and the Pacific Ocean nearshore environment under the Proposed Project, and therefore there would be a less than significant impact to pH in the long term.

The beneficial pH changes in the Middle Klamath River immediately downstream of Iron Gate Dam that would result from the conversion from a reservoir to a riverine system in the upstream Hydroelectric Reach, would occur immediately following dam removal, in the spring of dam removal year 2. In contrast, the potential for this reach to support periphyton growth along the river bed that increases variability in daily pH and potentially results in elevated pH values would be constrained in the short term because high SSCs and scour along the newly mobilized river bed during the winter and spring of dam removal year 2, and potentially also post-dam removal year 1, would limit establishment of extensive periphyton mats. Overall, in the short term, the Proposed Project would reduce the potential for a failure to meet the instantaneous maximum pH objective relative to the existing conditions and would be beneficial.

The Definite Plan (see Appendix B: *Definite Plan – Appendix M*) includes a Water Quality Monitoring Plan to assess the Proposed Project's impacts to water quality, and this plan includes pH monitoring. Please note that the State Water Board has authority to review and approve any final Water Quality Monitoring Plan through its water quality certification under Clean Water Act Section 401. The State Water Board has issued a draft water quality certification which sets forth monitoring and adaptive management requirements for any Water Quality Monitoring Plan to meet, as Condition 1[62]. Additionally, the Oregon Department of Environmental Quality has issued a water quality certification[63] that sets forth water quality monitoring and adaptive management conditions for points upstream of California. Because the effect of the Proposed Project on pH is anticipated to be beneficial or would not result in a significant impact in either the short and long term, this analysis of Potential Impact 3.2-11 does not further discuss the water quality monitoring and adaptive management conditions.

Significance

No significant impact for the Hydroelectric Reach at Oregon-California state line in the short term and long term.

Beneficial for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam in the short term and long term.

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[62] The State Water Board's draft water quality certification is available at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 14, 2018).

[63] The Oregon Department of Environmental Quality's final water quality certification is available at: https://www.oregon.gov/deq/FilterDocs/ferc14803final.pdf (Accessed December 14, 2018).

No significant impact for the Middle Klamath River downstream of Iron Gate Dam, the Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment in the short term and long term.

3.2.5.6 Chlorophyll-a and Algal Toxins

Potential Impact 3.2-12 Alterations in chlorophyll-*a* and algal toxins due to a conversion of the reservoir areas to a free-flowing river.

While fast-moving rivers do not provide good habitat for phytoplankton growth, slow-moving, calm water like the reservoirs created by Copco No. 1 and Iron Gate dams provide ideal habitat conditions for phytoplankton growth, especially blue-green algae species (see Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*, Section 3.4.2.1 *Phytoplankton*, and Appendix C – *Section C.6 Chlorophyll-a and Algal Toxins*). Chlorophyll-*a* is a pigment produced by phytoplankton, including blue-green algae, so concentrations of chlorophyll-*a* are often used to evaluate whether there is excessive phytoplankton growth in rivers, lakes, or reservoirs. Most importantly, several types of blue-green algae produce algal toxins, especially during excessive growth of blue-green algae (i.e., blooms), that can have negative health impacts on animals and humans (see Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*, Section 3.4.2.1 *Phytoplankton*, and Appendix C – *Section C.6 Chlorophyll-a and Algal Toxins*). Thus, the potential changes to chlorophyll-*a* and algal toxins due to conversion of the reservoir areas to a free-flowing river are evaluated to determine the potential impacts to water quality.

Hydroelectric Reach

Despite the slightly increased total nutrient concentrations anticipated under the Proposed Project in the Hydroelectric Reach (see Potential Impact 3.2-8), elimination of the slow-moving reservoir environment that currently supports growth for toxin-producing nuisance blue-green algae (e.g., *Microcystis aeruginosa*) would decrease the occurrence of high seasonal concentrations of chlorophyll-a (concentrations greater than 10 ug/L) and periodically high levels of algal toxins (concentrations greater than 0.8 and/or 4 ug/L microcystin; see Section 3.2.3.1 *Thresholds of Significance*) generated by suspended blue-green algae (see Potential Impact 3.4-2). This would be a beneficial effect.

Drawdown of the reservoirs would begin in winter and would be largely complete by March/April (i.e., the beginning of the algal growth season) of dam removal year 2, so complete elimination of the reservoir environment under the Proposed Project would occur by the end of dam removal year 2. Thus, the decrease in high seasonal chlorophyll-a concentrations and periodic high algal toxin concentrations would also occur by the end of dam removal year 2 due to the elimination of reservoir habitat that supported algal growth. Therefore, reductions in chlorophyll-a and algal toxins in the Hydroelectric Reach would be a short-term benefit as well as a long-term benefit since the reduction would begin during dam removal year 2 and it would continue beyond post-dam removal year 1.

Middle and Lower Klamath River and the Klamath River Estuary

In addition to the decreases in the occurrence of high seasonal concentrations of chlorophyll-a (concentrations greater than 10 ug/L) and periodically high levels of algal toxins (concentrations greater than 0.8 and/or 4 ug/L microcystin; see Section 3.2.3.1 *Thresholds of Significance*) generated by nuisance blue-green algae that are described for the Hydroelectric Reach, transport and growth of Microcystis aeruginosa in the

Middle and Lower Klamath River would be substantially reduced or eliminated in the absence of significant Lower Klamath Project reservoir blooms. Genetic and toxin analyses show that the *Microcystis aeruginosa* populations in Copco No. 1 and Iron Gate reservoirs are genetically distinct from each other and upstream populations, providing evidence that blue-green algae blooms in Iron Gate Reservoir are internally derived and not due to transport of *Microcystis aeruginosa* populations from Copco No. 1 Reservoir or further upstream (Otten et al. 2015). While algal toxins generated in Copco No. 1 could be transported downstream, Otten et al. (2015) document with genetic analysis that algal production in Iron Gate Reservoir is the principal source of *Microcystis aeruginosa* responsible for the observed public health exceedances occurring in the Klamath River downstream from Iron Gate Dam (see Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*, Section 3.4.2.3 *[Phytoplankton and Periphyton] Hydroelectric Reach* and Appendix C, Section C.6 *Chlorophyll-a and Algal Toxins*). Therefore, removal of the reservoirs under the Proposed Project would eliminate *in situ* production of seasonal blue-green algae blooms and the associated algal toxins and chlorophyll-*a*. While algal toxins and chlorophyll-*a* produced in Upper Klamath Lake may still be transported downstream after dam removal, existing data indicate that microcystin concentrations in the Klamath River decrease to below California water quality objectives (see Section 3.2.3.1 *Thresholds of Significance*) by the upstream end of J.C. Boyle Reservoir, regardless of the microcystin concentration measured leaving the Upper Klamath Lake (Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016). Thus, algal toxins and chlorophyll-*a* production upstream of J.C. Boyle Dam would not be expected to be transported into California and result in algal toxin or chlorophyll-*a* concentrations in a manner that would cause or substantially exacerbate an exceedance of water quality standards or would result in a failure to maintain existing beneficial uses currently supported.

Drawdown of the reservoirs would begin in winter and would be largely complete by March/April (i.e., the beginning of the growth season) of dam removal year 2, so complete elimination of the reservoir environment that transports blue-green algae, algal toxins, and chlorophyll-*a* in the Middle and Lower Klamath River and the Klamath River Estuary would occur by the end of dam removal year 2 under the Proposed Project. Thus, the decrease in high seasonal chlorophyll-*a* concentrations and periodic high algal toxin concentrations would also occur by the end of dam removal year 2 in the Middle and Lower Klamath River and the Klamath River Estuary due to the elimination of the upstream reservoir habitat. Therefore, reductions in chlorophyll-*a* and algal toxins in the Middle and Lower Klamath River and the Klamath River Estuary would be a short-term benefit as well as a long-term benefit.

The Definite Plan (see Appendix B: *Definite Plan – Appendix M*) includes a Water Quality Monitoring Plan to assess the Proposed Project's impacts to water quality, and this plan includes monitoring of microcystin-producing blue-green algae cell counts. Please note that the State Water Board has authority to review and approve any final Water Quality Monitoring Plan through its water quality certification under Clean Water Act Section 401. The State Water Board has issued a draft water quality certification which sets forth monitoring and adaptive management requirements for any Water

Quality Monitoring Plan to meet, as Condition 1[64]. Additionally, the Oregon Department of Environmental Quality has issued a water quality certification[65] that sets forth water quality monitoring and adaptive management conditions for points upstream of California. The effect of the Proposed Project on chlorophyll-*a* and algal toxins is anticipated to be beneficial in both the short and long term, and this analysis of Potential Impact 3.2-12 does not further discuss the water quality monitoring and adaptive management conditions.

Significance

Beneficial for the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary

3.2.5.7 Inorganic and Organic Contaminants

Potential Impact 3.2-13 Human exposure to inorganic and organic contaminants due to release and exposure of reservoir sediment deposits.

This potential impact evaluates the potential human exposure to inorganic and organic contaminants in sediments remaining within the reservoir footprints and along the river banks in addition to potential inorganic and organic contaminant concentrations in the river water in the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary due to the release of sediments currently trapped behind the Lower Klamath Project dams. The two main ways people would be potentially exposed to inorganic or organic contaminants in reservoir sediments would be through direct contact with reservoir sediments or eating fish or shellfish exposed to inorganic or organic contaminants in reservoir sediments. Direct human exposure to reservoir sediments due to recreational uses (e.g., camping, fishing, rafting) are evaluated by comparing inorganic and organic contaminant levels measured in reservoir sediments with USEPA and CalEPA screening levels that are conservatively protective of human health. Human exposure to inorganic and organic contaminants from eating fish or shellfish (e.g., mussels) is evaluated by comparison with available screening level values (SLVs) that assess whether contaminants in sediment would increase in fish or shellfish (i.e., bioaccumulate) to unhealthy levels for humans who eat them. While less likely than direct contact with remaining reservoir sediments after drawdown or eating fish exposed to inorganic and organic contaminants, people also would potentially be exposed to inorganic and organic contaminants from reservoir sediments in river water during drawdown when reservoir sediments and associated inorganic and organic contaminants were being transported. Human exposure to inorganic and organic contaminants from exposure to river water through consumption during drawdown and the transport of reservoirs sediments in the Klamath River is analyzed by comparing applicable human health drinking water standards[66] with the range of potential inorganic and organic contaminant concentrations in the elutriate samples, representing the highest potential concentration of these contaminants during drawdown. Comparison of

[64] The State Water Board's draft water quality certification is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 11, 2018).

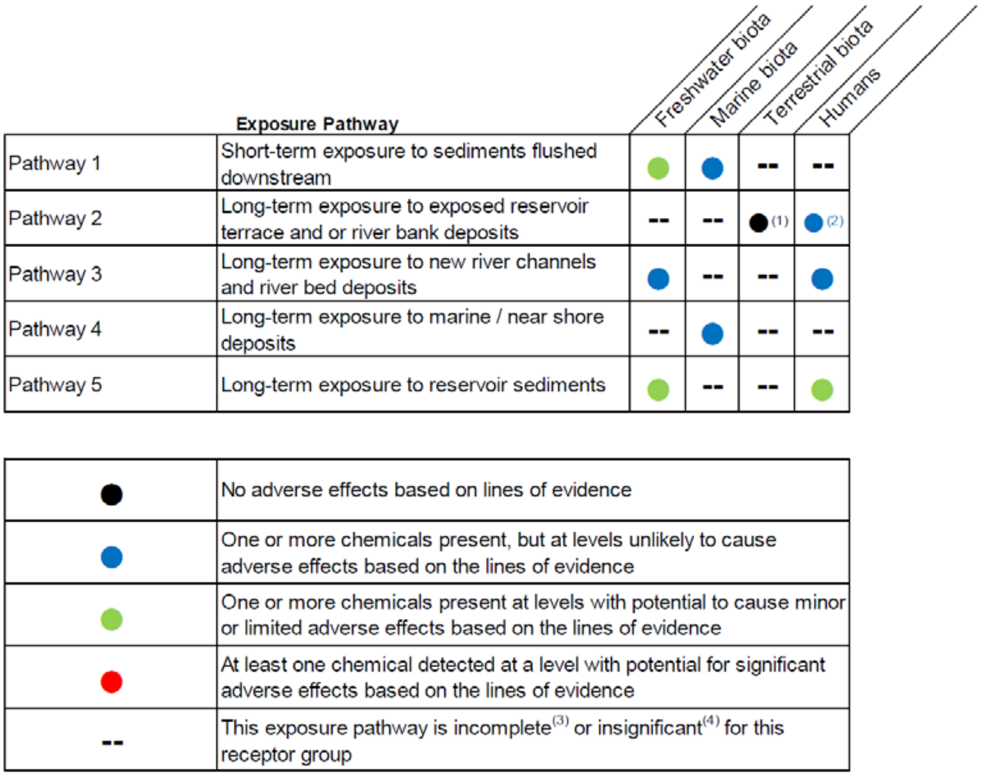
[65] The Oregon Department of Environmental Quality's final water quality certification is available online at: https://www.oregon.gov/deq/FilterDocs/ferc14803final.pdf (Accessed December 11, 2018).

[66] Human Health drinking water standards are listed Table B-6 of the Screening-Level Evaluation of Contaminants in Sediments from Three Reservoirs and the Estuary of the Klamath River, 2009-2011 (CDM 2011), which is included by reference and provided in Appendix W of this EIR.

the applicable human health drinking water standards with reservoir elutriate sample concentrations identified arsenic, aluminum, total PCB, chromium, and lead as detected potential chemicals of concern during reservoir drawdown (CDM 2011) and these are evaluated in more detail with consideration of actual concentrations expected during drawdown below. In a review of records maintained by the State Water Board's Division of Water Rights and Division of Drinking Water, only two drinking water diversions were identified in the Klamath River below Iron Gate Dam: (1) CalTrans' Randolph E. Collier Northbound and Southbound Rest Areas located near Hornbrook; and (2) Klamath Community Services District in Del Norte County located near the mouth of the Klamath River. The analysis below addresses the potential drinking water impacts to the Klamath River between the Oregon-California state line to the Klamath River Estuary, with consideration of the Hydroelectric Reach between J.C. Boyle Reservoir and the Oregon-California state line only to the extent it would influence downstream conditions in California.

Hydroelectric Reach

Potential human health risks associated with exposure to remaining sediment deposits within the reservoir footprints (i.e., "exposed reservoir terraces" as defined by CDM [2011]) and river banks within the Hydroelectric Reach were evaluated using comparisons of the 2009–2010 Klamath Dam Removal Secretarial Determination reservoir sediment core data to USEPA and CalEPA residential soil screening levels, and calculation of human/mammal toxic equivalency values (TEQs) ("Exposure Pathway 2 and 3" in CDM [2011]) (Figure 3.2-27). The analysis of exposure pathways using the 2009 SEF screening levels was updated based on 2018 SEF screening levels, as appropriate (Appendix C – *Section C.7*).



Note:
This does not include an evaluation of the physical effects (e.g., dissolved oxygen in the water, suspended sediment)
(1) Qualitative evaluation conducted for this exposure pathway
(2) Limited quantitative, along with qualitative evaluations conducted for this exposure pathway
(3) Incomplete - receptor group is unlikely to come in contact with sediment-associated contaminants under this exposure pathway
(4) Insignificant - exposure pathway not considered a major contributor to adverse effects in humans based on best professional judgment

Figure 3.2-27. Summary of Exposure Pathway Conclusions for Inorganic and Organic Contaminants. Source: CDM 2011.

As part of the Secretarial Determination process, the Water Quality Sub-Team identified USEPA soil screening levels and CalEPA California Human Health Screening Levels (CHHSLs) for soil as appropriate thresholds for determining the potential for sediment contaminants to adversely affect human health. USEPA residential exposure uses a 30-year exposure duration, 365 days per year exposure frequency with a soil ingestion rate of 200 mg/day for children over 6 years and 100 mg/day for adults over 24 years (USEPA 1991). CalEPA CHHSLs are based on the USEPA approach, with the residential exposure using a 30 year duration, 350 days per year exposure frequency with a soil ingestion rate of 200 mg/day for children over 6 years and 100 mg/day for adults over 24 years and the commercial exposure using a 25 year duration, 250 days per year exposure frequency with a soil ingestion rate of 200 mg/day for children over 6 years and 100 mg/day for adults over 24 years (CalEPA OEHHA 2005). In the short term, human exposure to inorganic and organic contaminants in sediments deposited on exposed reservoir terraces and river banks within the Hydroelectric Reach would be limited, short duration, non-residential exposure patterns (e.g., construction and restoration activities), resulting in less exposure to inorganic or organic contaminants (i.e., a lower ingestion rate of soil) than assumed for the USEPA and CalEPA screening levels. For example, construction/restoration worker exposure of 100 days per year for 5 years would result in only 4.8 percent of the CalEPA residential exposure. While the USEPA and CalEPA residential and commercial soil screening levels are used to evaluate the potential for adverse effects to humans, applying the USEPA and CalEPA screening levels considerably overstates the potential impact and the presence of a chemical at concentrations in excess of a USEPA and/or CalEPA screening level does not indicate that adverse impacts to human health would occur. Thus, the initial analysis of potential exposure and conclusions based on the USEPA and CalEPA screening levels would provide a very conservative estimate of potential adverse effects to humans and further interpretation of the comparisons of screening levels and inorganic and organic contaminant results, including an analysis of the exposure pathways, is necessary to assess the actual potential for human health impacts.

USEPA provides screening levels for both total carcinogenic (potentially cancer-causing) and total non-carcinogenic (not associated with cancer risk) contaminants. No reservoir sediment samples exceeded the total non-carcinogenic screening levels. Forty-five samples exceeded the USEPA total carcinogenic screening level for residential soils for arsenic or nickel, including samples from J.C. Boyle, Copco No. 1 and Iron Gate reservoirs. Those forty-five samples also exceeded the CalEPA residential and commercial screening levels for arsenic, but they did not exceed the CalEPA screening levels for nickel.

For arsenic, sampled concentrations in the reservoirs ranged from 4.3 to 15 mg/kg (see Section 3.2.2.8 *Inorganic and Organic Contaminants* and Appendix C, Table C-6), which is within the range of available measured arsenic soil concentrations for the Klamath Basin. Arsenic ranges from 0.8 to 23 mg/kg in regional soil samples from the Mid- and Lower Klamath Basin outside of the reservoir areas with typical arsenic concentrations between 2 and 7 mg/kg (USGS NGS 2008). Arsenic may be naturally elevated in the Upper Klamath Basin, with arsenic ranging from approximately 0.6 to 43.0 mg/kg and average regional background arsenic concentrations of 3.99 mg/kg ± 5.03 mg/kg in the vicinity of Upper Klamath Lake (Sturdevant 2010; ODEQ 2013; Sullivan and Round 2016). In comparison, the USEPA total carcinogenic screening level for soils is 0.39 mg/kg and the CalEPA specifies a California Human Health residential soil (0.07 mg/kg) and a commercial soil (0.24 mg/kg) screening levels.

In the long term, the Proposed Project includes the transfer of PacifiCorp lands immediately surrounding the Lower Klamath Project ("Parcel B lands") (Figure 2.7-18) from PacifiCorp to the KRRC prior to dam removal. The Proposed Project provides that the KRRC will transfer Parcel B lands to the respective states (i.e., California, Oregon), as applicable, or to a designated third-party transferee, following dam removal. The lands would thereafter be managed for public interest purposes (e.g., tribal mitigation, river-based recreation, wetland restoration, etc.) (KHSA Section 7.6.4). Pursuant to the KHSA, decisions about the land use would occur following dam removal, and the outcome of who the lands will ultimately be transferred to and what they will be used for is uncertain. Potential human exposure to arsenic measured in the Lower Klamath Project reservoir sediments under the Proposed Project would be less than that assumed for the USEPA or CalEPA screening levels since the reservoir footprint areas would be unlikely to support residential uses. Further, the exposure potential on the future public lands is likely to be considerably less than the exposure potential for residential uses. Limited, short duration, non-residential exposure patterns (e.g., recreational use) would result in less exposure to arsenic (i.e., a lower ingestion rate of soil). For example, recreational exposure of 10 to 90 days per year, every year for 30 years would result in only 3 to 25 percent of the residential exposure. Thus, overall the Proposed Project would be unlikely to result in short-term or long-term substantive adverse impacts on human health under possible "Exposure Pathway 2" due to arsenic.

For nickel, sampled concentrations in the reservoirs ranged from 18 to 33 mg/kg (see Appendix C, Table C-6), while the USEPA total carcinogenic screening level is 0.38 mg/kg and the CalEPA screening level is 1,600 mg/kg for residential exposure and 16,000 mg/kg for commercial exposure. As with arsenic, available Klamath Basin soil concentrations of nickel (median values 33 mg/kg and 65.7 mg/kg from two different studies) are in the same range as those measured in Lower Klamath Project reservoir sediments (see Appendix C – *Section C.7.1*) and they exceed the USEPA total carcinogenic screening level for residential soils by a similar factor. As discussed above for arsenic, the Parcel B lands would be transferred to the respective states as part of the Proposed Project and managed for public interest purposes, so potential human exposure to nickel measured in the Lower Klamath Project reservoir sediments under the Proposed Project would be less than that assumed for the USEPA or CalEPA screening levels. The exposure potential on the future public lands is likely to be considerably less than that for residential or commercial uses considered in USEPA and CalEPA screening levels, with recreational use resulting in only 3 to 25 percent of the residential exposure conservatively assuming 10 to 90 days per year, for 30 years exposure patterns. The highest concentrations of nickel were found in sediments from the Klamath River Estuary, which suggests that release of reservoir sediments downstream would not increase nickel concentrations in downstream reaches above existing conditions. Accordingly, the Proposed Project and release of sediments from behind the Lower Klamath Project dams is unlikely to increase the short-term or long-term exposure of humans to concentrations of nickel above Klamath Basin background levels and to result in substantive adverse impacts to human health under possible Exposure Pathway 2 from nickel.

There were 19 analytes measured during 2009 and 2010 that were not detected by laboratory tests; however, the laboratory analytical reporting limits were greater than the applicable human health screening levels (i.e., the standard laboratory tests used could not measure whether the analytes were present above human screening levels because the smallest amount the laboratory tests could detect [i.e., the reporting limit] for those analytes was greater than the human health screening level itself), including some PCBs, VOCs, and SVOCs (CDM 2011). While it is not possible to directly confirm that these compounds are above or below applicable human health screening levels, as described above for arsenic, potential human exposure to reservoir sediment deposits under the Proposed Project, in both the short-term and long-term, would involve limited, short duration, non-residential exposure patterns. Since these analytes were below levels of laboratory detection, and the potential exposure in the short and long-term would be less than the long-term residential levels of exposure, any undetected analytes would be unlikely to result in substantial adverse impacts on human health.

Elutriate concentration results (characterizing the water between grains of sediment, which can also be referred to as pore water) from the 2009–2010 sediment testing are used to evaluate human consumption exposure to inorganic and organic contaminants in river water during drawdown and transport of reservoirs sediments in the Klamath River. Elutriate concentration results represent the maximum potential concentration of contaminants in the Klamath River during drawdown since they do not take into account the mixing or dilution that would occur during transport of reservoir sediments (CDM 2011). Applicable human health drinking water standards are first compared with elutriate concentrations to provide an initial conservative assessment of human exposure to inorganic and organic contaminants, then elutriate concentrations with consideration of the expected dilution during drawdown are compared with the applicable human health drinking water standards to assess likely human exposure risk.

The dilution of inorganic and organic contaminant elutriate concentrations necessary during drawdown to meet applicable drinking water standards is determined from modeled SSCs since the SRH-1D sediment transport model uses drawdown flows similar to those expected under the Proposed Project in its estimates of SSCs. Variations in flow and dilution downstream of the reservoirs during drawdown would be inherently included in the modeled SSCs so variations in the contaminant concentrations with the potential to adversely impact human health would also be represented within these model results. The ratio of contaminant concentration to SSCs measured in laboratory elutriate tests is assumed to be equal to the ratio of the contaminant concentration to modeled SSCs in the Klamath River during drawdown (CDM 2011). As such, the dilution would decrease as the SSCs increase and the range of dilution in the Klamath River during drawdown can be calculated from the range of maximum modeled SSCs.

In the Hydroelectric Reach downstream of J.C. Boyle to the upstream end of Copco No. 1 Reservoir, the maximum SSCs would range from 2,000–3,000 mg/L (see Potential Impact 3.2-3), so dilution of mobilized sediments with reservoir and river water is expected to range from 217- to 325-fold (i.e., concentration in the river would be 217 to 325 times less than the elutriate concentration) immediately downstream of J.C. Boyle during drawdown. In the remainder of the Hydroelectric Reach from the upstream end of Copco No. 1 Reservoir through Iron Gate Reservoir, short-term SSC generally increase in the downstream direction due to the larger sediment deposits in Copco No. 1 and Iron Gate reservoirs contributing to SSCs. The minimum dilution in the Klamath River would occur immediately downstream of Iron Gate Dam during drawdown, where the maximum SSCs would occur from release of sediments in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs. The minimum dilution downstream of Iron Gate Dam would range from 48- to 66-fold (CDM 2011). As a conservative estimate, the J.C. Boyle dilution is used from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir and the expected dilution immediately downstream of Iron Gate is used from Copco No. 1 Reservoir to Iron Gate Dam for the analysis of human exposure to inorganic and organic contaminants in the Hydroelectric Reach. The actual SSCs in the Hydroelectric Reach in Copco No. 1 Reservoir to Iron Gate Dam potentially would be less than the maximum SSCs estimated below Iron Gate Dam based on modeled SSCs below the J.C. Boyle and Copco No. 1 dams (see Potential Impact 3.2-3), so the inorganic and organic contaminant concentrations and human exposure to those contaminants in the Hydroelectric Reach of the Klamath River would be less than those estimated using the maximum SSCs estimated below Iron Gate Dam.

Before consideration of dilution, aluminum, arsenic, chromium, lead, and total PCB are the only chemicals present in elutriate sediment sample results at concentrations above Basin Plan, national priority, and national non-priority fresh water quality criteria for samples from J.C. Boyle, Copco No. 1, and Iron Gate reservoirs (CDM 2011). After consideration of dilution, chromium, lead, and total PCB concentrations would be less than the most stringent human health drinking water standards in the Hydroelectric

Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir since the dilution in that portion of the Hydroelectric Reach (217- to 325-fold) is greater than the dilution necessary to meet the most stringent human health drinking water standards for chromium (12-fold), lead (0.3-fold), and total PCB (45-fold). Even after consideration of dilution, aluminum and arsenic concentrations would be greater than the most stringent applicable drinking water standards in the Hydroelectric Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir, since the minimum dilution in this portion of the Hydroelectric Reach (217-fold) would be less the dilution necessary for aluminum (219-fold) and arsenic (13,635-fold). In the Copco No. 1 Reservoir to Iron Gate Dam portion of the Hydroelectric Reach after consideration of the range of dilution (48- to 66-fold), the concentrations of chromium and lead would be less than the most stringent applicable drinking water standards. However, aluminum, arsenic, and total PCB concentrations would be greater than the most stringent applicable drinking water standards in this portion of the Hydroelectric Reach, since the range of anticipated dilution immediately downstream of Iron Gate Dam would be less than the dilution for aluminum (219-fold), arsenic (13,635-fold), and total PCB (100-fold) (CDM 2011).

While human exposure to contaminants in Klamath River water would be limited due to restricted access within the Hydroelectric Reach during drawdown, human exposure to concentrations of aluminum, arsenic, and total PCB greater than applicable drinking water standards would potentially occur during drawdown due to elevated SSCs and sediment-associated inorganic and organic contaminants and potentially cause substantial adverse impacts on human health if river water were to be used during drawdown as a drinking water supply. Dilution in the Klamath River necessary to meet the most stringent applicable drinking water standards (i.e., 13,635-fold for arsenic) would occur once SSCs decrease below 47 mg/L. Modeled SSCs are greater than 47 mg/L in the Hydroelectric Reach for approximately six to ten consecutive months after drawdown begins (see Potential Impact 3.2-3), so exposure to inorganic and organic contaminants in reservoir sediments that would potentially cause substantial adverse impacts on human health also would occur in the Hydroelectric Reach for approximately six to ten months during this period. In dry water year types, modeled SSCs downstream of Iron Gate Dam increase above 47 mg/L for approximately five to six months during the winter and spring after dam removal due to high flow associated with storms (see Figure 3.2-15), thus there also would be potential human exposure to contaminant concentrations (i.e., arsenic) above the most stringent applicable drinking water standards during this period. This would be a significant impact. Implementation of Mitigation Measure WQ-2 would reduce this impact to a less than significant level. Modeled SSCs downstream of Iron Gate Dam are consistently below 47 mg/L after July of post-dam removal year 1, (see Figures 3.2-15 to 3.2-17), indicating potential human exposure to contaminant concentrations that could cause substantial adverse impacts would be negligible after July of post-dam removal year 1 and thus there would be no significant impact after this point in time.

Long-term human exposure to concentrations of aluminum, arsenic, and total PCB greater than applicable drinking water standards due to dam removal is not anticipated since modeled SSCs would return to background levels (i.e., existing conditions) and there would be negligible deposition of reservoir sediments and the associated inorganic and organic contaminants in Hydroelectric Reach. Potential human exposure to inorganic and organic contaminants is associated with elevated SSCs, thus modeling that indicates SSCs would return to background levels (i.e., existing conditions) by the end of post-dam removal year 1 under all water year types (see Potential Impact 3.2-3) also indicates that potential human exposure to contaminants would return to background levels in this time period. Additionally, sediment modeling indicates little to no deposition of the fine or coarser (e.g., sand) sediments in the Hydroelectric Reach (CDM 2011; USBR 2012), so there would be little to no potential exposure to reservoir sediments and associated contaminants due to deposition along the streambed.

As part of the Secretarial Determination process, the Water Quality Sub-Team identified ODEQ bioaccumulation SLVs as appropriate thresholds for determining the potential for sediment contaminants to bioaccumulate to the point where the contaminants adversely affect either the health of fish or other aquatic organisms, or the health of animals or humans that consume them. ODEQ bioaccumulation SLVs have been set for humans based on fish and shellfish consumption under both general/recreational and subsidence/tribal ingestion rates (ODEQ 2007). Bioaccumulation SLVs have not been set based on bioaccumulation within vegetation exposed to contaminants and the ingestion that vegetation. While ODEQ bioaccumulation SLVs are not applicable to water bodies in California, they provide a reference for comparison purposes. Toxicity equivalent quotients (TEQs) calculated for dioxin, furan, and dioxin-like PCBs were at concentrations above ODEQ bioaccumulation SLVs for mammals in sediments from each of the reservoirs (CDM 2011). Although site-specific background data is lacking, TEQs calculated for dioxin, furan, and dioxin-like PCBs are only slightly above regional background concentrations and thus have limited potential to cause adverse impacts to humans based on consumption of aquatic life exposed to sediment deposits from the river banks or streambed. This assessment is further supported by the limited duration contaminants would occur in the river water as they are transported with drawdown flows and the limited amount of deposition expected (see Potential Impact 3.11-5). The sources of the slightly elevated dioxin, furan, and dioxin-like PCB compounds are not known; however, sources may include atmospheric deposition, regional forest fires, and possibly burning of plastic items (CDM 2011).

Summary

Results from the 2009–2010 Klamath Dam Removal Secretarial Determination sediment chemistry analyses indicate potential human exposure to inorganic and organic contaminants in reservoir sediment deposits remaining within the reservoir footprints and along the river banks or through eating fish exposed to sediment deposits would be unlikely to result in substantive adverse impacts on human health in either the short-term or the long-term, but there is potential for short-term substantive adverse impacts on human health from exposure to inorganic and organic contaminants in reservoir sediments during drawdown due exposure to river water. For the Lower Klamath Project reservoir sediments remaining in the reservoir footprint and along the river banks, arsenic and nickel are the only compounds detected at levels exceeding USEPA and/or CalEPA residential screening levels to protect human health, but exposure to arsenic in these areas would be constrained by short-term activities and long-term future land use that would support only limited exposure patterns, such that human exposure to arsenic and nickel in sediments in the reservoir footprint would be a less-than-significant impact.

Evaluation of the bioaccumulation potential of inorganic and organic contaminants indicates there is limited potential for adverse impacts to humans from eating aquatic life exposed to sediment deposits from the river banks or streambed since the detected levels of dioxin, furan, and dioxin-like PCBs are only slightly above regional background concentrations. This assessment is further supported by the limited duration contaminants would occur in the river water as they are transported with drawdown flows and the limited amount of deposition expected (see Potential Impact 3.11-5). Thus, human exposure to these chemicals in aquatic life would be a less-than-significant impact.

For exposure to river water during drawdown, aluminum, arsenic, and total PCBs greater human health water quality criteria would potentially occur in the short term due to elevated SSCs and sediment-associated inorganic and organic contaminants and potentially cause substantial adverse impacts on human health; this would be a significant impact. Implementation of Mitigation Measure WQ-2 would reduce this impact to a less than significant level. There is little to no long-term potential for adverse impacts to human health from exposure to river water due the release of reservoir sediments and associated inorganic or organic contaminants trapped behind the Lower Klamath Project dams, so there would be no significant impact in the long term for human exposure to inorganic and organic contaminants in the Hydroelectric Reach.

Middle and Lower Klamath River and Klamath River Estuary

Downstream of Iron Gate Dam, short-term and long-term human exposure to contaminants from contact with residual sediments deposited on downstream river banks is possible and the mechanism for exposure would be the same as that for potential contaminants deposited on exposed reservoir terraces and river banks in the Hydroelectric Reach. Sediment deposition on the river floodplain and/or river banks is unlikely (see also Potential Impact 3.11-6), so the amount of sediment deposits on river floodplains and/or river banks are anticipated to be much lower than the amount exposed in the reservoir beds in the Hydroelectric Reach.

Relatively few compounds were detected in reservoir sediments exceeding human health screening levels for soil, with arsenic and nickel the only compounds exceeding USEPA and/or CalEPA residential screening levels to protect human health. The likelihood of substantial adverse impacts to human health from exposure to arsenic in reservoir sediments is low in the Middle and Lower Klamath River and the Klamath River Estuary since sediment modeling indicates sediment deposition on the river floodplain and/or river banks is unlikely (see also Potential Impact 3.11-6). Nickel concentrations in the Klamath River Estuary sediments were higher than those measured in reservoirs sediments, suggesting the release of reservoir sediments would not increase nickel concentrations in downstream reaches and the potential exposure to nickel in potential deposits of reservoir sediment in the Middle and Lower Klamath River and the Klamath River Estuary would likely be within background conditions.

However, in an abundance of caution, since land use along the Middle and Lower Klamath River floodplain includes residential or agricultural (i.e., row crop) land use or the potential for residential or agricultural (i.e., row crop) land use, where human soil exposure patterns may approach those specified by the USEPA and CalEPA residential screening levels, implementation of Mitigation Measure WQ-3 would be required to ensure that short-term and long-term human exposure to inorganic and organic contaminants due to release of sediments currently trapped behind the Lower Klamath Project dams to a less-than-significant impact.

Similar to the Hydroelectric Reach, there also is potential for human exposure to inorganic and organic contaminants in reservoir sediments from contact with river water during drawdown when reservoir sediments and associated inorganic and organic contaminants are being transported. Elutriate concentration results from 2009–2010 sediment testing along with an evaluation of the elutriate concentrations results with consideration of dilution in the Middle and Lower Klamath River and the Klamath River Estuary indicate the potential for human exposure to inorganic and organic contaminants greater than applicable human health drinking water standards that may cause substantial adverse impacts to human health. This would be a significant impact. As detailed above in the Hydroelectric Reach, the maximum potential human exposure exists immediately downstream of Iron Gate Dam during drawdown, where the maximum SSCs and the minimum dilution (48- to 66-fold) would occur. Additional tributary inflows to the Klamath River downstream of Iron Gate Dam would decrease the maximum SSCs and increase the dilution (see Potential Impact 3.2-3), so potential human exposure gradually decreases in the Middle and Lower Klamath River with distance downstream. In the Klamath River at Seiad Valley, the maximum modeled SSCs range from approximately 9,000–10,000 mg/L, so dilution is expected to range from approximately 65- to 72-fold in that section of the Middle Klamath River. The maximum modeled SSCs range from approximately 3,000–6,000 mg/L in the Klamath River at Orleans, resulting in dilution ranging from approximately 108- to 217-fold. In the Lower Klamath River at Klamath, the maximum modeled SSCs range from approximately 800–2,000 mg/L, so dilution ranges from 325- to 813-fold.

In the Middle Klamath River, the human exposure to inorganic and organic contaminants immediately downstream of Iron Gate Dam would be the same as analyzed above for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam. Before consideration of dilution, aluminum, arsenic, chromium, lead, and total PCB are the only chemicals present in elutriate sediment samples results at concentrations above applicable drinking water standards for samples from J.C. Boyle, Copco No. 1, and Iron Gate reservoirs (CDM 2011). After consideration of the dilution immediately downstream of Iron Gate Dam (48- to 66-fold), only aluminum, arsenic, and total PCB concentrations would be greater than the most stringent human health drinking water standards, since the anticipated dilution immediately downstream of Iron Gate would be less the maximum dilution necessary for aluminum (219-fold), arsenic (13,635-fold), and total PCB (100-fold), but the dilution immediately downstream of Iron Gate Dam would be greater than the maximum dilution necessary for chromium (12-fold) and lead (0.3-fold) (CDM 2011). While the maximum dilution necessary to meet the most stringent applicable human health drinking water standards would be met further downstream in the Middle and Lower Klamath for aluminum and total PCB as the dilution in the river increases, the dilution for arsenic would not be met in the Middle and Lower Klamath River and the Klamath River Estuary.

Elutriate sediment samples results from the Klamath River Estuary also show aluminum, arsenic, and total PCB concentrations greater than the most stringent applicable human health drinking water standards, indicating elevated concentrations of these chemicals occur under existing conditions in the Middle and Lower Klamath River and the Klamath River Estuary. However, the concentrations of these chemicals in the elutriate sediment samples results from the Klamath River Estuary are less than those measured in reservoir sediments. Arsenic concentrations in estuary elutriate sediment samples require a 999- to 2,726-fold dilution to meet the most stringent applicable human health drinking water standards, while aluminum requires a 14-fold dilution and total PCB requires a 1.0- to 1.5-fold dilution. Overall, human exposure to concentrations of aluminum, arsenic, and total PCB greater than applicable human health drinking water standards and existing conditions would potentially occur if river water were to be used during drawdown as a drinking water supply in the Middle and Lower Klamath River and the Klamath River Estuary. This would be a significant impact.

Similar to the Hydroelectric Reach, the dilution in the Middle and Lower Klamath River and the Klamath River Estuary necessary to meet the most stringent applicable human health drinking water standards (i.e., 13,635-fold for arsenic) would occur once SSCs decrease below 47 mg/L. As described for the Hydroelectric Reach, modeled SSCs immediately downstream of Iron Gate Dam are greater than 47 mg/L for approximately six to ten consecutive months after drawdown begins (see Potential Impact 3.2-3). While increased dilution with distance downstream of Iron Gate Dam would likely reduce the duration that SSCs exceed 47 mg/L and the duration of human exposure to elevated contaminant concentrations, this analysis conservatively applies the modeled SSCs immediately downstream of Iron Gate Dam for the entire Middle and Lower Klamath River and Klamath River Estuary. As such, the exposure to inorganic and organic contaminants in reservoir sediments that would potentially cause substantial adverse impacts on human health would occur in the Middle and Lower Klamath River and the Klamath River Estuary for approximately six to ten months after drawdown begins. In dry water year types, there also would be potential human exposure to contaminant concentrations (i.e., arsenic) above the most stringent applicable human health drinking water standards for approximately five to six months during the winter and spring after dam removal, since modeled SSCs immediately downstream of Iron Gate Dam increase during this period due to high flows associated with storms (see Figure 3.2-15). This would be a significant impact. Implementation of Mitigation Measure WQ-2 would reduce this impact to a less than significant level. Modeled SSCs downstream of Iron Gate Dam are consistently below 47 mg/L after July of post-dam removal year 1, (see Figure 3.2-15 to 3.2-17), indicating potential human exposure to contaminant concentrations that could cause substantial adverse impacts would be negligible after July of post-dam removal year 1 and thus there would be no significant impact after this point in time.

Long-term human exposure to concentrations of aluminum, arsenic, and total PCB levels greater than applicable human health drinking water standards due to dam removal is unlikely since modeled SSCs would return to background levels (i.e., existing conditions) and fine reservoir sediments and associated inorganic and organic contaminants would be unlikely to form sediment deposits in the Middle and Lower Klamath River and the Klamath River Estuary (see Potential Impact 3.11-5). Potential human exposure to inorganic and organic contaminants is associated with elevated SSCs, thus modeling that indicates SSCs would return to background levels (i.e., existing conditions) by the end of post-dam removal year 1 under all water year types (see Potential Impact 3.2-3) also indicates that potential human exposure to contaminants would return to background levels in this time period. Additionally, sediment modeling indicates fine reservoir sediments would be unlikely to settle along the riverbed in the Klamath River in the Middle and Lower Klamath River and the Klamath River Estuary (Stillwater Sciences 2008; USBR 2012) (see Potential Impact 3.11-5). Coarser reservoir sediment would potentially deposit between Iron Gate Dam and Cottonwood Creek (USBR 2012), but these sediments are not typically associated with appreciable contaminant levels due to their lack of organic matter and chemical properties (i.e., lower cation exchange capacities) (CDM 2011). Thus, there would be little to no potential long-term potential for adverse impacts to human health from exposure to river water due the release of reservoir sediments and associated inorganic or organic contaminants trapped behind the Lower Klamath Project dams, and there would be no significant impact in the long term for human exposure to inorganic and organic contaminants in the Hydroelectric Reach.

Implementation of mitigation measures WQ-2 and WQ-3 would reduce the short-term significant impact of human exposure to inorganic and organic contaminants in the Middle and Lower Klamath River and the Klamath River Estuary to less than significant.

Mitigation Measure WQ-2 – Modifications and monitoring for transient non-community and community water systems using the Klamath River for their water supply.

The KRRC shall consult with community water systems, transient non-community water systems, or other drinking water providers that use Klamath River surface water for drinking water to identify appropriate measures to reduce impacts associated with the Proposed Project's impacts to their Klamath River water supply, such that Proposed Project implementation shall not result in service of water that fails to meet drinking water quality standards. At least two months prior to initiating drawdown, the KRRC shall submit to the State Water Board a report detailing drinking water mitigation measures for each potentially affected supply and demonstrating that such measures are sufficient to protect drinking water supplies. KRRC shall amend the measures if required to protect drinking water supplies and shall implement them sufficiently prior to reservoir sediment releases to ensure protection of water supplies. Potential measures shall include, as appropriate: (1) providing an alternative potable water supply; (2) providing technical assistance to assess whether existing treatment is adequate to treat the potential increase in sediments and sediment-associated contaminants so as to meet drinking water standards; (3) providing water treatment assistance to adequately treat Klamath River water to remove SSCs and associated constituents that may impact human health; 4) ensuring that transient, non-community supplies are temporarily shut off for drinking; or 5) ensuring that water not intended for drinking is clearly marked as non-potable

Mitigation Measure WQ-3 – Monitoring and potential remediation of reservoir sediments deposited along the Middle and Lower Klamath River floodplain.

By December of post-dam removal year 1, and upon notice from property owners, the KRRC shall assess visibly obvious sediment deposits along with Middle and Lower Klamath River that may have been deposited during reservoir drawdown activities in areas with a residential or agricultural (i.e., row crop) land use or the potential for residential or agricultural land use. Visibly obvious sediment deposits shall be assessed by the KRRC if they are consistent with physical sediment properties associated with Lower Klamath Project reservoir sediments (see Section 3.11.2.5 *Reservoir Sediment Storage and Composition*). Visibly obvious sediment deposits consistent with physical sediment properties associated with Lower Klamath Project reservoirs shall be tested for arsenic. Soil samples in the vicinity of the deposited reservoir sediments on the river bank and/or floodplain shall also be tested for arsenic to determine the local background concentrations of arsenic. No additional actions or remediation shall be required if the measured arsenic concentrations in the deposited reservoir sediments are less than or equal to measured local background soil arsenic concentrations. If the concentration of arsenic in deposited reservoir sediments on the river banks and floodplain in the Middle and Lower Klamath River exceed local background levels and USEPA or CalEPA human health residential screening levels, the deposited reservoir sediments shall be remediated to local background levels through removal of the deposited reservoir sediments or soil capping, if soil removal is infeasible or poses a greater risk than soil capping.

Significance

No significant impact with mitigation

Potential Impact 3.2-14 Freshwater and marine aquatic species exposure to inorganic and organic contaminants due to release of sediments currently trapped behind the dams.

This potential impact evaluates the potential for any inorganic and organic contaminants in reservoir sediments to result in a substantial adverse impact to aquatic organisms when the sediments are released downstream of the dams into the Klamath River. The release of reservoir sediments has the potential to increase the exposure of aquatic species to any harmful material in the sediment by moving the sediments and associated contaminants to new places in the river; mixing the sediments and associated contaminants into the water column where aquatic life may interact with them; and, for some materials, creating conditions where contaminants may enter the food chain. Sediment testing indicates that the amounts of contaminants in the sediments is not high, but this analysis evaluates the level of risk and potential impacts in more detail with consideration of the conditions in the Klamath River under the Proposed Project, especially during drawdown.

Hydroelectric Reach

Organic and inorganic contaminants have been identified in the sediment deposits currently trapped behind the dams (see Section 3.2.2.8 *Inorganic and Organic Contaminants*). Under the Proposed Project, the short-term pathway of contaminant exposure for freshwater aquatic species includes exposure during sediment transit through the Hydroelectric Reach ("Exposure Pathway 1" in CDM [2011]), while long-term pathways include exposure from river bed deposits ("Exposure Pathway 3" in CDM [2011]) (Figure 3.2-27). The CDM (2011) analysis of exposure pathways using the 2009 SEF screening levels has been updated based on 2018 SEF screening levels, as appropriate (Appendix C – *Section C.7*).

One path for short-term exposure to inorganic and organic contaminants for freshwater aquatic species would be associated with the transport of elevated suspended sediment concentrations (SSCs) through the Hydroelectric Reach during reservoir drawdown. Due to the relatively small volume of the sediment deposits behind J.C. Boyle Dam (approximately eight percent of total volume for the Lower Klamath Project, see also Tables 2.7-9 and 2.7-10), short-term SSCs in the Hydroelectric Reach between J.C. Boyle Dam and the upstream end of Copco No. 1 Reservoir would be considerably less than those anticipated to occur downstream of Iron Gate Reservoir (see Potential Impact 3.2-3). The ratio of the contaminant concentration to SSCs measured in laboratory tests is assumed to be equal to the ratio of the contaminant concentration to SSCs in the Klamath River during drawdown, so the amount of dilution necessary to meet water quality standards would vary based on changes in SSC during drawdown. Variations in flow and dilution downstream of the reservoirs during drawdown would be inherently included in the modeled SSCs since the model utilizes expected drawdown flows in its estimate of SSCs. Thus, the maximum dilution necessary to meet water quality standards for aquatic species would be calculated using the maximum SSCs.

In the Hydroelectric Reach downstream of J.C. Boyle to the upstream end of Copco No. 1 Reservoir, the maximum SSCs would range from 2,000–3,000 mg/L (see Potential Impact 3.2-3), so dilution of mobilized sediments with reservoir and river water is expected to range from 217- to 325-fold immediately downstream of J.C. Boyle during drawdown. Within the remainder of the Hydroelectric Reach from the upstream end of Copco No. 1 Reservoir through Iron Gate Reservoir, short-term SSC would be relatively greater than upstream of Copco No. 1 Reservoir, generally increasing in the downstream direction due to the larger sediment deposits in Copco No. 1 and Iron Gate reservoirs contributing to SSCs. The minimum dilution in the Klamath River would occur immediately downstream of Iron Gate Dam during drawdown, where higher peak SSCs from release of sediments in Copco No. 1 and Iron Gate reservoirs would result in dilution ranging from 48- to 66-fold. As a conservative estimate, this analysis uses the J.C. Boyle dilution only for the J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoirs portion of the Hydroelectric Reach and the dilution expected immediately downstream of Iron Gate Dam for the remainder of the Hydroelectric Reach when evaluating the dilution necessary to meet water quality standards for contaminant results. The actual SSCs in the Hydroelectric Reach in Copco No. 1 Reservoir to Iron Gate Dam potentially would be less than the maximum SSCs estimated below Iron Gate Dam based on modeled SSCs below the J.C. Boyle and Copco No. 1 dams (see Impact 3.2-3), so the inorganic and organic contaminant concentrations and the aquatic species exposure to those contaminants in the Hydroelectric Reach of the Klamath River would be less than those estimated using the maximum SSCs estimated below Iron Gate Dam.

Sediment chemistry data from 2006 collected from 25 cores representing both reservoir-deposited and pre-reservoir sediments within the historical Klamath River channel ("on-thalweg") and on historical riverbanks and terraces along the edge of the Klamath River ("off-thalweg") in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs indicate generally low levels of metals, pesticides, chlorinated acid herbicides, PCBs, VOCs, SVOCs, cyanide, and dioxins (Shannon & Wilson, Inc. 2006; see also Section 3.2.2.8 *Inorganic and Organic Contaminants*). While two-dimensional sediment transport modeling of Copco No. 1 Dam and Reservoir during drawdown indicates that sediments would be mobilized from across the reservoir footprint, the sediments in the historical Klamath River channel would be the most likely to erode (USBR 2012) and thus the sediment chemistry of the on-thalweg sediment cores is more likely to be representative of eroded sediment conditions.

An additional 37 sediment cores were collected in 2009–2010 in the Lower Klamath Project reservoirs for the Klamath Dam Removal Secretarial Determination process to evaluate the sediment characteristics of reservoir-deposited and pre-reservoir sediments in the historical Klamath River channel ("on-thalweg") and terrace ("off-thalweg") locations at a finer spatial resolution. Testing results for the 2009–2010 cores indicate no exceedances of applicable screening levels, indicating a low risk of toxicity to freshwater sediment-dwelling organisms in the Hydroelectric Reach under the Proposed Project. Results from acute (10-day) sediment bioassays for exposure to undiluted reservoir sediments and elutriate samples for midges (*Chironomus dilutus*) and amphipods (*Hyalella azteca*), two national benchmark toxicity species, indicate generally equal survival in reservoir sediments as compared with laboratory control samples. The exception is J.C. Boyle Reservoir, which exhibited considerably lower survival for *Chironomus dilutus* in the on-thalweg sample as compared with the laboratory control (64 percent versus 95 percent) and somewhat lower survival for the off-thalweg sample (83 percent versus 95 percent) (CDM 2011).

While J.C. Boyle reservoir sediment results suggest potential toxicity to freshwater benthic organisms, the conditions in the bioassays would be very unlikely to occur during drawdown and dam removal in the Hydroelectric Reach downstream of J.C. Boyle Dam, so there is an overall low likelihood of acute toxicity to benthic organisms due to releases of reservoir sediments. The bioassays evaluated the survival of freshwater benthic organisms in composite[33] sediments from individual reservoirs, but undiluted composite sediments from the reservoirs would be very unlikely to occur outside of the reservoir footprints during drawdown and dam removal. Sediments from the reservoirs would mix with water and incoming suspended sediments from tributaries as they move downstream under the Proposed Project, exposing downstream aquatic biota to a diluted, "average" sediment composition rather than pure reservoir sediments. Under current conditions, the total volume of erodible sediments in Copco No. 1 and Iron Gate reservoirs (7.4 million and 4.7 million cubic yards, respectively; see also Tables 2.7-7 through 2.7-9) is considerably greater than that of J.C. Boyle Reservoir (1 million cubic yards; see also Tables 2.7-7 through 2.7-9), further diminishing the potential influence of J.C. Boyle Reservoir sediments on biota exposure. Additionally, fine sediments released during drawdown and dam removal would be transported by large water volumes, and sediment modeling indicates that fine sediments would be unlikely to settle along the riverbed in the Klamath River in the Hydroelectric Reach (Stillwater Sciences 2008; USBR 2012) and thus unlikely to result in riverine, floodplain, or estuarine sediment deposits that resemble existing conditions in the reservoirs.

More specifically, dilution would be expected to range from 217- to 325-fold downstream of J.C. Boyle Dam to the upstream end of Copco No. 1, so benthic organism exposure to inorganic and organic contaminants in J.C. Boyle Reservoir sediments would be much less during drawdown under the Proposed Project than in the bioassays. The intensity of exposure compared to the bioassays would be further reduced due to considerable additional mixing occurring within the Hydroelectric Reach from the current Copco No. 1 Reservoir to Iron Gate Dam. While dilution would decrease downstream of Copco No. 1 due to higher SSCs, the mixing of sediments from J.C. Boyle and Copco No. 1 along with additional mixing of water from Copco No. 1 would reduce the overall intensity of exposure to J.C. Boyle reservoir sediments. In the absence of undiluted sediment deposits from J.C. Boyle Reservoir, freshwater benthic organisms in the Hydroelectric Reach are unlikely to experience the same intensity of exposure to reservoir sediments as in the bioassays that suggested potential for toxicity (CDM 2011). Overall, the freshwater sediment bioassays indicate a low likelihood of acute toxicity to benthic organisms in the Hydroelectric Reach of the Klamath River due to sediment release under the Proposed Project.

Elutriate concentration results (representing the water between grains of sediment, which can also be referred to as pore water) from the 2009–2010 sediment testing also provide important context for evaluating the potential effects of in-water column exposure to inorganic and organic contaminants from reservoir sediments on aquatic freshwater species. Elutriate sediment sample chemistry results indicate that, before consideration of dilution, ammonia, aluminum, chromium, copper, lead, and mercury are the chemicals present at concentrations above Basin Plan, national priority, and national non-priority fresh water quality criteria for samples from J.C. Boyle, Copco No. 1, and Iron Gate reservoirs (CDM 2011). Human health freshwater water quality criteria were also evaluated (CDM 2011) and those results are analyzed above in Potential Impact 3.2-13. Dilution of mobilized sediments with reservoir and river water is expected to range from 217- to 325-fold downstream of J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir and 48- to 66-fold immediately downstream of Iron Gate during drawdown. Thus, the elutriate sediment sample concentrations for all the chemicals currently present at concentrations above water quality criteria (i.e., ammonia, aluminum, chromium, copper, lead and mercury) would be below the freshwater water quality criteria with dilution in the portion of the Hydroelectric Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir. Inorganic and organic contaminants would be unlikely to cause adverse effects to freshwater aquatic species in the J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir portion of the Hydroelectric Reach since the dilution required to meet the most stringent criterion is 22-fold (i.e., the elutriate concentration would have to be 22 times higher than the water quality standard concentration to exceed criterion) for ammonia, 125-fold for aluminum, 0.2-fold for chromium, 2.3-fold for copper, 2.1-fold for lead, and 1.3-fold for mercury. However, the dilution in the Copco No. 1 Reservoir to Iron Gate Dam portion of the Hydroelectric Reach would be less than upstream, reaching a minimum of 48- to 66-fold at Iron Gate Dam due to release of additional sediment from Copco No. 1 and Iron Gate reservoirs and higher SSCs. Elutriate sediment sample concentrations in the Copco No. 1 Reservoir to Iron Gate Dam portion of the Hydroelectric Reach would be below the freshwater water quality criteria for ammonia, chromium, copper, lead, and mercury after consideration of dilution with no potential to cause substantial adverse impacts on freshwater aquatic species.

For aluminum, the expected dilution at Iron Gate Dam is less than the dilution required for three of the six elutriate sediment samples to meet the most stringent freshwater criterion (87 ug/L) with those three samples requiring a 50- to 125-fold dilution. While some inorganic forms of aluminum can be toxic to aquatic organisms at high and low pH, insoluble and nontoxic forms of aluminum prevail in the environment under typical conditions (pH ranging from six to eight s.u. and alkalinity greater than 100 mg/L). The pH conditions at drawdown are not anticipated to be in the range that would cause inorganic aluminum to become toxic. Thus, any residual free (toxic) aluminum present in reservoir waters during drawdown is likely to form compounds with the dissolved organic matter abundant in eutrophic (nutrient-rich) waters such as the Lower Klamath Project reservoirs, rendering the aluminum non-bioavailable and nontoxic. Thus, water column toxicity due to the concentration of inorganic or organic substances under the Proposed Project is unlikely (CDM 2011) and would not result in substantial adverse impacts on environmental receptors.

Elutriate sediment sample bioassay results for J.C. Boyle Reservoir indicate that no further dilution would be required to prevent water column toxicity to freshwater fish, even without considering the dilution that will take place during drawdown and dam removal (CDM 2011). Elutriate sediment sample bioassay results indicate no statistically significant reduction of mean 96-hour rainbow trout survival for exposure to samples from Copco No. 1 and Iron Gate reservoirs, tested at one percent and 10 percent elutriate concentrations, but a significant reduction from Copco No. 1 Reservoir at 100 percent elutriate concentrations and from Iron Gate Reservoir at 50 percent and 100 percent elutriate concentration. Of these, the one percent and 10 percent concentrations are considered to be most representative of field conditions upon reservoir drawdown due to the expectation of substantial mixing and dilution with river water and tributary inputs, even during dry water years (CDM 2011).

Long-term exposure to reservoir sediments that are mobilized as a result of dam removal would not result in substantial adverse impacts on aquatic species due to negligible deposition of these sediments in Hydroelectric Reach and the overall infrequency and low magnitude of exceedances of screening levels for inorganic and organic contaminants. Sediment modeling indicates that the fine grain nature of the sediments (i.e., silts and clays) and the generally high gradient river channel within the Hydroelectric Reach would result in little to no deposition of the fine or coarser (e.g., sand) sediments in the Hydroelectric Reach of the Klamath River (CDM 2011; USBR 2012).

Additionally, no consistent pattern of elevated chemical distribution was observed across the reservoir samples, with only eight chemicals detected in the 77 samples that exceeded one or more available screening level (see Section 3.2.2.8 *Inorganic and Organic Contaminants*). Nickel was the only one of those eight chemicals that exceeded both SEF screening levels in all three reservoirs. However, nickel is higher in Klamath River Estuary sediments (representing current Klamath Basin background conditions) than reservoir sediments, so reservoir sediments would not elevate nickel concentrations above background conditions. The absence of a consistent pattern of elevated chemical concentrations in reservoir sediment samples supports the conclusion that mixing and dilution of mobilized sediments during drawdown would reduce the overall chemical concentrations in the water column and any sediment deposits and further reduce exposure potential in the newly formed river channels of the Hydroelectric Reach (CDM 2011).

Combined, results from the Shannon & Wilson, Inc. (2006) study and the 2009–2010 Klamath Dam Removal Secretarial Determination study (CDM 2011) indicate that currently one or more chemicals are present in the Lower Klamath Project reservoir sediments at levels with potential to cause minor or limited adverse impacts on freshwater aquatic species. However, chemicals present in the Lower Klamath Project reservoir sediments are expected to be mixed and diluted below water quality standards reducing the likelihood of causing even minor or limited adverse impacts on freshwater aquatic species in the short term. In the long term, one or more chemicals are present, but at levels unlikely to cause substantial adverse impacts on environmental receptors. Therefore, under the Proposed Project, the short-term and long-term impacts on freshwater aquatic species from exposure to sediment-associated inorganic and organic contaminants during sediment release and transit, and from potential downstream river-channel deposition, in the Hydroelectric Reach, would be a less-than-significant impact.

Middle and Lower Klamath River

Organic and inorganic contaminants have been identified in the sediment deposits currently trapped behind the dams (see Section 3.2.2.8). Under the Proposed Project, the short-term pathway of contaminant exposure for freshwater aquatic species includes exposure during sediment transit through the Middle and Lower Klamath River ("Exposure Pathway 1" in CDM [2011]), while long-term pathways include exposure from river bed deposits ("Exposure Pathway 3" in CDM [2011]). The CDM (2011) analysis of exposure pathways using the 2009 SEF screening levels has been updated based on 2018 SEF screening levels, as appropriate (Appendix C – *Section C.7*).

As detailed above for the Hydroelectric Reach, sediment chemistry data from 25 cores collected from Lower Klamath Project reservoirs in 2006 and from an additional 37 sediment cores collected in 2009–2010 indicate generally low levels of metals, pesticides, chlorinated acid herbicides, PCBs, VOCs, SVOCs, cyanide, and dioxins (Shannon & Wilson, Inc. 2006; see also Section 3.2.2.8 *Inorganic and Organic Contaminants*) and no exceedances of applicable screening levels, indicating a low risk of toxicity to freshwater sediment-dwelling organisms in the Middle and Lower Klamath River under the Proposed Project. Acute (10-day) sediment bioassays for exposure to undiluted reservoir sediments and elutriate samples for midges (*Chironomus dilutus*) and amphipods (*Hyalella azteca*), two national benchmark toxicity species, indicate generally equal survival in reservoir sediments as compared with laboratory control samples, except for J.C. Boyle Reservoir sediments (see discussion in the Hydroelectric Reach above). Similar to the Hydroelectric Reach, the conditions in the bioassays would be very unlikely to occur during drawdown and dam removal in the Klamath River downstream of Iron Gate Dam because the downstream aquatic biota would be exposed to a diluted "average" sediment composition rather than pure reservoir sediments analyzed in the bioassays. As such, the potential toxicity of J.C. Boyle Reservoir sediments on downstream biota would be significantly reduced compared to the bioassays, especially downstream of Iron Gate Dam due to considerable mixing and dilution within the Hydroelectric Reach. Additionally, any natural background sediments or flows from tributaries (e.g., Bogus Creek, Shasta River) entering the Klamath River downstream of Iron Gate Dam would further mix and dilute sediments, reducing exposure relative to the bioassays. Fine sediments released during drawdown and dam removal would be transported and unlikely to settle along the riverbed in the Klamath River downstream of Iron Gate Dam (USBR 2012; Stillwater Sciences 2008), so any potential riverine, floodplain, or estuarine sediment deposits that resemble existing conditions in the reservoirs are very unlikely. In the absence of undiluted sediment deposits from J.C. Boyle Reservoir, freshwater benthic organisms downstream of Iron Gate Dam are unlikely to experience the same intensity of exposure to reservoir sediments as in the bioassays that suggested potential for toxicity (CDM 2011). Overall, the freshwater sediment bioassays indicate a low likelihood of acute toxicity to benthic organisms in the Middle and Lower Klamath River due to sediment release under the Proposed Project.

As previously discussed for the Hydroelectric Reach, elutriate concentration results from 2009-2010 also provide important context for evaluating the potential effects of in-water column exposure to inorganic and organic contaminants from reservoir sediments on aquatic freshwater species. Elutriate sediment sample chemistry results indicate that, before consideration of dilution, ammonia, aluminum, chromium, copper, lead, and mercury are the chemicals present at concentrations above Basin Plan, national priority, and national non-priority fresh water quality criteria for samples from J.C. Boyle, Copco No. 1, and Iron Gate reservoirs (CDM 2011). However, dilution of mobilized sediments with reservoir and river water is expected to range from 48- to 66-fold immediately downstream of Iron Gate during drawdown, with further dilution occurring downstream from Iron Gate Dam due to tributary inflows. Elutriate sediment sample concentrations of ammonia, chromium, copper, lead and mercury would be below the freshwater water quality criteria after consideration of dilution immediately downstream of Iron Gate Dam with no potential to cause substantial adverse impacts on freshwater aquatic species since the dilution required to meet the most stringent criterion is 22-fold for ammonia, 0.2-fold for chromium, 2.3-fold for copper, 2.1-fold for lead, and 1.3-fold for mercury.

For aluminum, the expected dilution downstream of Iron Gate Dam is less than the dilution required for three of the six elutriate sediment samples to meet the most stringent freshwater criterion (87 ug/L) with those three samples requiring a 50- to 125-

fold dilution. While some inorganic forms of aluminum can be toxic to aquatic organisms at high and low pH, insoluble and nontoxic forms of aluminum prevail in the environment under typical conditions (pH ranging from six to eight s.u. and alkalinity greater than 100 mg/L). The pH conditions at drawdown are not anticipated to be in the range that would cause inorganic aluminum to become toxic. Thus, any residual free (toxic) aluminum present in reservoir waters during drawdown is likely to form compounds with the dissolved organic matter abundant in eutrophic (nutrient-rich) waters such as the Lower Klamath Project reservoirs, rendering the aluminum non-bioavailable and nontoxic. Thus, water column toxicity due to the concentration of inorganic or organic substances under the Proposed Project is unlikely (CDM 2011).

Elutriate sediment sample bioassay results indicate no statistically significant reduction of mean 96-hour rainbow trout survival for exposure to samples from Copco No. 1 and Iron Gate reservoirs, tested at one percent and 10 percent elutriate concentrations, but a significant reduction from Copco No. 1 Reservoir at 100 percent elutriate concentrations and from Iron Gate Reservoir at 50 percent and 100 percent elutriate concentration. Of these, the one percent and 10 percent concentrations are considered to be most representative of field conditions upon reservoir drawdown due to the expectation of substantial mixing and dilution with river water and tributary inputs, even during dry water years (CDM 2011).

Long-term exposure to reservoir sediments that are mobilized as a result of dam removal downstream of Iron Gate Dam are similar to those analyzed in the Hydroelectric Reach and release of reservoir sediments is unlikely to result in substantial adverse impacts on aquatic species due to minimal deposition of these sediments in the downstream river channel and the overall infrequency and low magnitude of exceedances of screening levels for inorganic and organic contaminants. No consistent pattern of elevated chemical distribution was observed across the reservoir samples, with only eight chemicals detected in the 77 samples that exceeded one or more available screening level (see Section 3.2.2.8 *Inorganic and Organic Contaminants*). Nickel was the only one of those eight chemicals that exceeded both SEF screening levels in all three reservoirs. Nickel is higher in Klamath River Estuary sediments (representing current Klamath Basin background conditions) than reservoir sediments, so reservoir sediments would not elevate nickel concentrations above background conditions. The absence of a consistent pattern of elevated chemical concentrations in reservoir sediment samples supports the conclusion that mixing and dilution of mobilized sediments during drawdown would reduce that overall chemical concentrations in the water column and any sediment deposits and further reduce exposure potential in the Middle and Lower Klamath River (CDM 2011).

Overall, one or more chemicals are currently present in the Lower Klamath Project reservoir sediments at levels with potential to cause minor or limited adverse impacts on freshwater aquatic species in the short term, based results from the Shannon & Wilson, Inc. (2006) study and the 2009–2010 Klamath Dam Removal Secretarial Determination study (CDM 2011), but chemicals present in the Lower Klamath Project reservoir sediments are expected to be mixed and diluted below water quality standards, reducing the likelihood of any substantial adverse impacts on freshwater aquatic species in the short term. In the long term, one or more chemicals are present, but at levels unlikely to cause substantial adverse impacts based on available evidence. Therefore, under the Proposed Project, the short-term and long-term impacts on freshwater aquatic species from exposure to sediment-associated inorganic and organic contaminants during sediment release and transit, and from potential downstream river-channel deposition, in the Middle and Lower Klamath River, would be a less-than-significant impact.

Klamath River Estuary and Pacific Ocean Nearshore Environment

Under the Proposed Project, pathways of contaminant exposure for estuarine and marine aquatic species include short-term exposure during sediment transport through the Klamath River Estuary and Pacific Ocean nearshore environment ("Exposure Pathway 1" in CDM [2011]), as well as the potential for long-term exposure following deposition in the Pacific Ocean nearshore environment ("Exposure Pathway 4" in CDM [2011]). See Potential Impact 3.11-6 for further discussion of sediment deposition patterns in the Pacific Ocean nearshore environment.

For the 2009–2010 Klamath Dam Removal Secretarial Determination study, there were no exceedances of the 64 applicable and available maximum marine screening levels (CDM 2011), with the exception of a small number of sediment samples from J.C. Boyle Reservoir, which exceeded the applicable marine screening level for dieldrin[67] and 2,3,4,7,8-PECDF[68] (CDM 2011). The concentrations of detected inorganic or organic contaminants in Lower Klamath Project reservoir sediments were below the concentrations measured in Klamath River Estuary sediments for chromium and nickel, so the release of reservoir sediments from behind the Lower Klamath Project dams would not elevate estuarine concentrations of these inorganic or organic contaminants or increase exposure for freshwater aquatic species relative to existing conditions. In reservoir sediments total chromium concentrations ranged from 18 to 48 mg/kg and total nickel concentrations ranged from 18 to 33 mg/kg, but in Klamath River Estuary sediments total chromium concentrations ranged from 96 to 97 mg/kg and total nickel concentrations were consistently 110 mg/kg. Marine screening levels are designed to be protective of direct toxicity to benthic and epibenthic organisms, corresponding to a "no adverse effects level," so the majority of sediment sample results from 2009 and 2010 indicate a low risk of toxicity to sediment-dwelling organisms. Additionally, the Proposed Project would result in substantial mixing and dilution during sediment release and transit through the Klamath River estuarine and/or Pacific Ocean nearshore environment, exposing downstream aquatic biota to an "average" water column concentration rather than a reservoir- or site-specific concentration, further reducing the potential for toxicity. The standard laboratory tests used could not measure whether 33 analytes were present above marine screening levels because the smallest amount the laboratory tests could detect (i.e., the reporting limit) for those analytes was greater than the marine screening level itself (CDM 2011). Because it is not possible to determine whether these analytes are present in reservoir sediments either above or below levels of concern, the Lower Klamath Project EIR analysis relies upon the results of integrative bioassays (described below) to determine the potential for short-term sediment toxicity to estuarine and marine aquatic species during sediment transport through the Klamath River Estuary and Pacific Ocean nearshore environment.

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[67] Dieldrin is a pesticide developed in the 1940s as an alternative to DDT and widely used during the 1950s until early 1970s on crops such as corn and cotton. Its use on crops ceased in 1972 and its other use, killing termites, ceased in 1987, but it is still in the environment due to its past use and slow breakdown in soil (USDHHS 2002).

[68] 2,3,4,7,8-PECDF is a chlorodibenzofuran (i.e., dioxin-like) compound that can be released during burning of material, including wood, coal, and oil for home heating and production of electricity. It is also produced during the manufacture of some chlorinated chemicals and consumer products, such as wood treatment chemicals (e.g., creosote), some metals, and paper products (USDHHS 1994).

Sediment bioassays from a single upper Klamath River Estuary sample included in the 2009–2010 Klamath Dam Removal Secretarial Determination study indicate greater survival (89 to 99 percent survival) of national benchmark toxicity species (midge [*Chironomus dilutus*] and amphipod [*Hyalella azteca*]) in the estuary sediment sample as compared with the laboratory control samples (81 to 94 percent survival) (see CDM 2011). A simple comparison between the estuary area composite acute toxicity results and the reservoir super-composite results indicates similar survival for *Chironomus dilutus* (89 percent vs. 64 to 94 percent, respectively) and greater survival for *Hyalella azteca* (99 percent vs. 80 to 94 percent, respectively). The toxicity tests of estuary and reservoir sediments show the existing background toxicity of estuary sediments is similar to the toxicity of reservoir sediments, so under the Proposed Project, sediment transport during drawdown and potential exposure to inorganic and organic contaminants in the reservoir sediments are unlikely to cause acute toxicity relative to background conditions in the estuary. For the Pacific Ocean nearshore environment under the Proposed Project, a comparison of the applicable marine water and sediment screening levels for ocean conditions with elutriate chemistry results (prior to consideration for mixing and dilution) and sediment chemistry results does not indicate likely toxicity (CDM 2011).

With respect to bioaccumulation potential, there are no exceedances of applicable marine bioaccumulation screening levels (CDM 2011). Further, with the exception of four samples in J.C. Boyle Reservoir (CDM 2011), levels of other known bioaccumulative compounds did not exceed ODEQ bioaccumulation screening level values (SLVs) for marine fish. Note that ODEQ bioaccumulatory screening levels are not strictly applicable in the California marine offshore environment, but they are indicative of potentially bioaccumulative compounds.

Regarding analysis through the pathway of suspended sediment exposure, elutriate chemistry results indicate that several chemical concentrations in the elutriate samples from J.C. Boyle, Copco No. 1, Iron Gate reservoir sediments and Klamath River Estuary sediments exceed one or more water quality criteria for evaluation of surface water exposures for marine biota. Chemicals that exceed marine surface water criteria include those generally considered to be nontoxic (e.g., phosphorus) as well as those with substantial potential for contributing to adverse impacts (e.g., copper). Exposures to suspended sediment with elevated concentrations of potentially toxic chemicals are of lower concern for marine receptors than exposures to elevated concentrations of dissolved chemicals (CDM 2011). The chemicals with the greatest potential to cause adverse impacts due to their elutriate sample concentrations (e.g., copper) are, under field conditions associated with this exposure pathway, expected to bind to particulate matter and no longer be bioavailable, and therefore are unlikely to contribute substantially to elevated concentrations of dissolved forms in the water column. Further, 48- to 66-fold dilution of river water and associated suspended sediments is expected to occur immediately downstream of Iron Gate Dam with further dilution occurring downstream and in the marine environment. The dilution required to meet the most stringent marine water quality criteria for the detected elutriate chemicals ranges from 0.1- to 40-fold with the exception of phosphorus, so the expected dilution during dam removal would be greater than that required to meet marine water quality criteria. Phosphorous would require 1,299 to 5,399-fold dilution to meet the most stringent marine water quality criterion (0.1 ug/L[69]), but phosphorus is generally considered to be non-toxic (CDM 2011). Potential effects of elevated phosphorus concentrations in the estuarine and marine environment due to sediment releases during dam removal are discussed further under Potential Impact 3.2-7.

Although not conducted specifically for estuarine or marine organisms, additional lines of evidence from the 2009–2010 Klamath Dam Removal Secretarial Determination study support the conclusion that exposure to inorganic and organic compounds in sediments released from the reservoirs under the Proposed Project are unlikely to result in substantial long-term adverse impacts on estuarine and marine near shore aquatic species. These include the evaluation of elutriate toxicity bioassay results for rainbow trout, sediment toxicity bioassay results for benthic invertebrate national benchmark species, comparisons of tissue-based toxicity reference values (TRVs) to chemical concentrations in laboratory-reared freshwater clams and worms exposed to field collected sediments (see prior discussion of Proposed Project potential impacts on freshwater aquatic species), and comparisons of tissue-based TRVs and toxicity equivalent quotients (TEQs) to chemical concentrations in field-collected fish tissue.

Under the Proposed Project, the short-term and long-term impacts of sediment release, transit through the Klamath River Estuary, and deposition in the Pacific Ocean nearshore environment on aquatic species due to low-level exposure to sediment-associated inorganic and organic contaminants would be less-than-significant.

The Definite Plan (see Appendix B: *Definite Plan – Appendix M*) includes a Water Quality Monitoring Plan to assess the Proposed Project's impacts to water quality, and this plan includes potential toxicity monitoring, but no toxicity monitoring activities are currently included. The proposed Water Quality Monitoring Plan notes that the identified potential toxicity monitoring activities would only be performed if the additional testing is required by the State Water Board. The State Water Board has authority to review and approve any final Water Quality Monitoring Plan through its water quality certification under Clean Water Act Section 401. The State Water Board has issued a draft water quality certification which sets forth monitoring and adaptive management requirements for any Water Quality Monitoring Plan to meet, as Condition 1[70]. Additionally, the Oregon Department of Environmental Quality has issued a water quality certification[71] that sets forth water quality monitoring and adaptive management conditions for points upstream of California. The effect of the Proposed Project on inorganic and organic contaminants is anticipated to be less than significant in both the short and long term, and this analysis of Potential Impact 3.2-14 does not further discuss the water quality monitoring and adaptive management conditions.

Significance

No significant impact

[69] National Recommended Water Quality Criteria for Non-Priority Pollutants, Marine Criterion Continuous Concentration [chronic].
[70] The State Water Board's draft water quality certification is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 11, 2018).
[71] The Oregon Department of Environmental Quality's final water quality certification is available online at: https://www.oregon.gov/deq/FilterDocs/ferc14803final.pdf (Accessed December 11, 2018).

Potential Impact 3.2-15 Short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration activities in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam.

Under the Proposed Project, pre-construction activities that would potentially affect water quality include canal and diversion tunnel modifications, road improvements, Iron Gate and Fall Creek hatchery modifications, Yreka pipeline modifications, and dam site preparation between June and November of dam removal year 1 (Table 2.7-1). Immediately following dam removal, non-natural fish barriers would be modified to enable volitional fish passage. Facility removal activities would begin in October of dam removal year 1 with removal of the Copco No. 1 Powerplant, including demolition of the dams and their associated structures, power generation facilities, and transmission lines, installation of temporary cofferdams, hauling, recreation facilities removal, regrading of recreation access roads and parking areas, and other activities (Table 2.7-1). Short-term restoration activities would include irrigation system installation and maintenance, as well as active seeding, planting, and weed management in the reservoir footprint and disturbed upland areas within the Limits of Work (Table 2.7-1). All of the aforementioned activities could result in the disturbance of reservoir sediment deposits remaining within the reservoir footprints and result in inorganic and organic contaminants in those sediments entering the Klamath River. Additionally, use of heavy construction equipment and construction-related vehicles involves gasoline, other petroleum fuels, hydraulic and lubricating fluids and other materials, which have the potential to contaminate waters should they be captured in site stormwater runoff or due to accidents. Please see Potential Impact 3.2-4 potential stormwater-related impacts to water quality and Potential Impact 3.22-2 for consideration of the accidental release of hazardous materials from construction equipment and/or vehicles under the Proposed Project.

As discussed in Potential Impact 3.2-4, the Proposed Project includes construction and other ground-disturbing BMPs to reduce potential impacts to water quality in wetlands and other surface waters during construction (Appendix B: *Definite Plan – Appendix J*). Those BMPs focus on general stormwater-related contamination as well as fuels, oils, and lubricants; however, their implementation would also minimize or eliminate the potential for increases in inorganic and organic contaminants that could enter wetlands and other surface waters located within the Limits of Work (Figures 2.2-5, 2.7-2, and 2.7-4), including the Hydroelectric Reach, tributaries of the Klamath River that enter this reach (as appropriate), or the Middle Klamath River immediately downstream of Iron Gate Dam due to construction and other ground-disturbing activities. However, the Proposed Project does not specify BMPs for pre-construction, reservoir restoration, or upland restoration activities. Further, the proposed BMPs are not sufficiently comprehensive to avoid all potential violations of water quality standards or otherwise degrade water quality in affected portions of the wetlands, Hydroelectric Reach, tributaries to the Klamath River that enter this reach (as appropriate), or the Middle Klamath River immediately downstream of Iron Gate Dam, during these other periods of Proposed Project activity. Thus, short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration activities would potentially result in substantial adverse impacts on human health or environmental receptors and there could be significant impacts without mitigation to water quality in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam. Implementation of Mitigation Measures WQ-1, TER-1, and HZ-1 would reduce this impact to less than significant.

Significance

No significant impact with mitigation

Potential Impact 3.2-16 Short-term impacts to aquatic biota from herbicide application during restoration of the reservoir areas.

The Proposed Project Reservoir Restoration Plan includes active seeding and planting of vegetation in drained reservoir areas to stabilize the surface of the sediment and minimize erosion from exposed terrace surfaces following drawdown (Appendix B: *Definite Plan – Appendix H*). An invasive exotic vegetation (IEV) management plan would be implemented to control terrestrial invasive exotic plant species. As part of the management plan, IEV surveys would be undertaken prior to dam removal year 1 and year 2 and non-herbicide methods of integrative pest management (e.g., manual weed pulling, mowing or cutting, mechanical eradication by tilling in larger areas, grazing, shading, and solarization) would be used first to remove IEVs within the Limits of Work. As a last resort and only when other methods prove to be ineffective or potentially cause more harm than benefit within the environment, herbicides would be used to control the growth of invasive exotic vegetation species, with application by wicking or brushing occurring during dam removal year 2.

Herbicide use to control invasive exotic vegetation species has the potential to contaminate the Klamath River through runoff or drift without proper selection, handling, and application. KRRC has proposed to avoid this risk to the extent possible by only using herbicides after non-chemical control methods have proven ineffective or may cause more harm than benefit to the environment. The only herbicides used would be those approved for use by the Bureau of Land Management (BLM), California Department of Fish and Wildlife (CDFW), North Coast Regional Board, USFWS, and NMFS in California. If herbicide application becomes the necessary method for effective IEV control, the KRRC would consider only those application methods with the least side-effects to native vegetation and wildlife and would base application methods on plant reproduction, structure, and growth. Monitoring and management of invasive plant species would continue after dam removal year 2 with the potential for further herbicide application, if the latter offers the most effective methods for control and eradication of noxious weeds (Appendix B: *Definite Plan – Appendix H*).

While the Proposed Project includes strategies to avoid and minimize runoff that is toxic to aquatic biota from herbicide application, the Reservoir Restoration Plan included in the Definite Plan (see Appendix B: *Definite Plan – Appendix H*) lacks specificity regarding certain herbicide formulations and application practices that could result in short-term aquatic toxicity within the Hydroelectric Reach during reservoir restoration activities, which would constitute a substantial adverse impact on aquatic biota and thus would be a significant impact.

Under the Proposed Project, the Reservoir Restoration Plan would be further developed by KRRC working with the appropriate agencies through the FERC process, and it would be subject to State Water Board approval. In addition, it would also be appropriate for the Final Reservoir Restoration Plan to include Mitigation Measure WQ-4, which provides further protections for aquatic biota in relation to control of terrestrial invasive exotic plant species via herbicide application.

Mitigation Measure WQ-4 Herbicide Characteristics and Application Approach. Aquatic formulations of glyphosate (i.e., Glyfos Aquatic) are developed for use in sensitive protected environments such as habitat restoration sites and wetlands. If glyphosate is chosen as a suitable herbicide for IEV management, then an aquatic formulation shall be used and glyphosate formulations containing POEA or R-11 shall be avoided to reduce risks to amphibians and other aquatic organisms. Additionally, glyphosate shall not be applied when weather reports predict precipitation within 24 hours of application, before or after. If another herbicide is chosen, it shall meet the characteristics of low soil mobility and low toxicity to fish and aquatic organisms and shall be applied using low use rates (i.e., spot treatments), avoidance of application in the rain, avoidance of treatments during periods when fish are in life stages most sensitive to the herbicide(s) used, and adherence to appropriate buffer zones around stream channels as specified in BLM (2010).

Significance
No significant impact with mitigation

3.2.5.8 General Water Quality

Potential Impact 3.2-17 Short-term and long-term influence of changes in Iron Gate and Fall Creek hatchery production on Klamath River and Fall Creek water quality. Under the Proposed Project, the Iron Gate Hatchery facilities would be modified from existing conditions and the nearby Fall Creek Hatchery would be reopened (see Section 2.7.6 *Hatchery Operations* for more details). As part of the Proposed Project, the existing adult fish ladder and holding tanks at the base of Iron Gate Dam and the cold-water supply and aerator for the hatchery would be removed, while other hatchery features would remain in place and would be altered for limited operations during dam removal year 2 and the subsequent seven years post-dam removal (eight years total) (see Section 2.7.6.1 *Iron Gate Hatchery* for more details). Fall Creek Hatchery has not been used to produce fish since 2003, so existing facilities would be upgraded for raising coho salmon and Chinook salmon as part of reopening Fall Creek Hatchery, and new facilities (e.g., a settling pond, vehicle parking, pertinent buildings, tagging trailer, etc.) would be constructed (see Section 2.7.6.2 *Fall Creek Hatchery* for more details). As with Iron Gate Hatchery, it would operate for eight years in total, starting in dam removal year 2. As the hatchery facilities would operate for eight years and then close, for this potential impact, short-term is defined as through the eight-year period of operation, and long-term is defined as the period thereafter.

Total hatchery production under the Proposed Project would be reduced from current levels. Iron Gate Hatchery Chinook salmon smolt production goals would be reduced to 3,400,000 under the Proposed Project and fall-run Chinook and coho yearling salmon and steelhead production goals would be reduced to zero since they would no longer be produced at Iron Gate Hatchery (Table 2.7-13). In tandem with fish production decreases at Iron Gate Hatchery, production at Fall Creek Hatchery would increase from zero under existing conditions to 75,000 coho yearlings and 115,000 Chinook yearlings. No Chinook smolts and no steelhead would be produced at Fall Creek Hatchery (see also Section 2.7.6.2 *Fall Creek Hatchery*). While the hatchery production goals have been set, the ability to meet the production varies annually based on adult returns and hatchery performance. At Iron Gate Hatchery, the fall-run Chinook salmon yearling smolt goals and coho salmon yearling smolt goals have been achieved on average since

2005 but fall-run Chinook salmon age zero smolts are typically approximately one million smolts less than production goals (K. Pomeroy, CDFW, pers. comm., 2018) and no steelhead have been released since 2012 (NMFS and CDFW 2018). After considering the actual production achieved, hatchery operations under the Proposed Project would constitute a reduction in production from existing conditions of approximately 87 percent for yearling fall-run Chinook salmon smolts, 20 percent for fall-run Chinook salmon age zero smolts, 100 percent for steelhead, and zero percent for coho salmon smolts (see Section 3.3.5.6 *Fish Hatcheries* for more details).

Hatcheries potentially alter water temperature through increasing exposure to direct sunlight (e.g., in raceways or settling ponds) and ambient air temperatures. Hatcheries also potentially increase suspended material, turbidity, and nutrients in streams by discharging water containing organic solids from uneaten commercial pelletized feed and fish waste. Hatchery discharges may also alter dissolved oxygen, pH, and salinity in streams by discharging water with dissolved oxygen, pH, or salinity different than the streams into which the discharge is released. Differences in dissolved oxygen can be due to hatchery fish respiration, biochemical oxygen demand (BOD) from organic solids associated with fish feed, biological growth (e.g., algae and bacteria) in the hatchery and settling ponds or use of chemicals to manage hatchery conditions (e.g., fish disease). Use of water treatment chemicals, drugs, and/or vaccines to treat illnesses within hatchery fish or prevent detrimental fungal or bacterial conditions also has the potential to alter the inorganic and organic contaminants (ICF 2010). The impacts of hatchery operations and discharges of hatchery effluent on Klamath River water quality would be similar or would decrease under the Proposed Project compared to existing conditions, as current production goal would be reduced, resulting in an overall decrease in potential suspended material, nutrient, or water treatment chemical releases in the system as a whole.

Under the Proposed Project, water temperature effects from Iron Gate Hatchery would likely be similar to existing conditions since lower production and proposed modifications at the hatchery would not significantly alter the area of the raceways and settling tanks that are exposed to sunlight or air temperatures. However, suspended material, turbidity, nutrients, dissolved oxygen, pH, salinity, and inorganic and organic contaminants from the combined operation of Iron Gate Hatchery and Fall Creek in the Klamath River downstream of Iron Gate Hatchery would decrease under the Proposed Project compared to existing conditions since lower fish production would require less feed and less frequent use of chemicals to manage hatchery conditions.

Feed is a major source of organic material, nutrients, and BOD; therefore, reductions in fish production and feed at Iron Gate Hatchery under the Proposed Project also would correspond to a reduction in total nitrogen (TN), total phosphorus (TP), and carbonaceous biological oxygen demand (CBOD)[72] loads from the hatchery. Thus, while Iron Gate Hatchery currently exceeds its TMDL allocation of zero net discharge of nitrogen, phosphorous and biological oxygen demand, these existing exceedances to the Klamath River would be reduced under the Proposed Project for eight years of hatchery operations and would then be eliminated. Overall, the decrease in total hatchery fish production would maintain or improve return water quality conditions

[72] Carbonaceous biological oxygen demand (CBOD) is used instead of BOD to evaluate the organic matter loads in the Klamath River TMDL California Compliance Conditions. BOD is equal to the CBOD plus the nitrogenous biological oxygen demand (NBOD).

downstream of Iron Gate Hatchery as compared to existing conditions, so there would be no significant impact on water quality below Iron Gate Hatchery in the short term or long-term due to changes in fish production under the Proposed Project.

For the stretch of river that is between the Fall Creek Hatchery downstream to Iron Gate Hatchery, there would be a net increase in hatchery-related discharges as compared to the existing condition, because Fall Creek Hatchery is currently not operating. The reopening of Fall Creek Hatchery and production of fish at the hatchery for eight years (i.e., dam removal year 2 and the subsequent seven years post-dam removal) under the Proposed Project would potentially alter the short-term (dam removal year 2 through post-dam removal year 1) and long-term (after post-dam removal year 1) water quality conditions in Fall Creek downstream of the hatchery (Figure 2.7-15). The fish ladder would continuously discharge water from the rearing tanks, except during periods of cleaning, feeding, or chemical use to treat fish illnesses (i.e., therapeutics). The settling pond is proposed for construction on one of two potential nearby sites[73] and would discharge all water from the rearing ponds after cleaning, feeding, or therapeutic use along with all water from the incubation and spawning operations. Fall Creek water quality below Fall Creek Hatchery would be primarily influenced by the hatchery discharges downstream of the settling pond (maximum of approximately 0.35 mile upstream of Fall Creek's confluence with the Klamath River) but Fall Creek water quality potentially would also be influenced by hatchery discharges up to the adult fish ladder (approximately 0.87 mile upstream from Fall Creek's confluence with the Klamath River).

Fall Creek Hatchery operations and effluent discharge would potentially alter water temperature downstream of the hatchery discharge points, but the change in water temperature would be minimal. Water temperature data from 11 hatcheries and concurrent water temperature measurements upstream and downstream of the hatchery discharge indicate the average change in water temperature downstream of the hatchery discharge ranged from -0.5ºF to 2.2ºF, with a 0.1ºF or less change in water temperature downstream of more than half of the hatcheries (ICF 2010). While the water temperature impacts of most hatcheries were limited, there were three instances (i.e., 1 percent of all available data) where the water temperature downstream of a hatchery was 5ºF greater than the water temperature upstream, including one occasion at Iron Gate Hatchery in June 2008. In all three instances, hatchery discharge was warmer than the upstream water temperature, but it was less than the downstream water temperature, suggesting that factors in addition to hatchery operations may have influenced water temperature in the stream (ICF 2010). Fall Creek Hatchery is generally shady and therefore unlikely to have the same solar radiation impacts as Iron Gate Hatchery. However, there is the potential for the hatchery to elevate temperatures

Overall, Fall Creek Hatchery discharges potentially would alter water temperature between -0.5ºF to 2.2ºF, and there is significant potential that Fall Creek Hatchery discharges would result in exceedances of water quality standards for water temperature. Fall Creek is an interstate water originating in Oregon, so potential water temperature increases in the stream from hatchery discharges would result in an exceedance of the Thermal Plan water temperature water quality standard for interstate waters that prohibit the discharge of elevated temperature waters into **COLD** interstate

[73] Selection of the settling pond site is pending cultural resources investigations and consultation with tribes with historical and cultural connection to the area (see also Section 2.7.6.2 *Fall Creek Hatchery*).

waters (Table 3.2-4) and there would be a significant and unavoidable impact without mitigation to water temperature in Fall Creek due to Fall Creek Hatchery under the Proposed Project. While water temperature data in the Klamath River upstream and downstream of the confluence of Fall Creek is unavailable to determine the influence of Fall Creek water temperature on Klamath River water temperatures, the average monthly water temperature in Fall Creek is typically colder than the average monthly water temperature of the Klamath River upstream of Copco No. 1 during April through September (FERC 2007). Thus, Fall Creek would potentially be a source of cold water to the Klamath River during portions of the year and an increase in Fall Creek water temperature due to Fall Creek Hatchery discharges potentially would result in an increase in Klamath River water temperature. While the increase in Fall Creek water temperature and subsequent potential increase in Klamath River water temperature due to hatchery discharges would be small, any increase in water temperature would exceed Thermal Plan water temperature water quality standard for **COLD** interstate waters and there potentially would be a significant and unavoidable impact without mitigation on water temperature in the Hydroelectric Reach of the Klamath River due to Fall Creek Hatchery under the Proposed Project.

Fall Creek Hatchery discharges potentially would increase suspended material in Fall Creek by discharging water containing organic solids from uneaten commercial pelletized feed and fish waste, but those increases remain less than the suspended sediment thresholds of significance. The measured maximum net TSS resulting from the discharge of 19 existing CDFW hatcheries ranged from less than 5.0 mg/L to 25.6 mg/L, with TSS equal to or greater than 5 mg/L in hatchery discharges occurring at 12 of the 19 hatcheries (ICF 2010). At those 12 hatcheries, TSS was equal to or greater than 5 mg/L less than once a year (1 out of 57 measurements at Iron Gate Hatchery) to approximately twice per year (13 out of 120 measurements at Hot Creek Hatchery). Additionally, the TSS was measured directly in the hatchery discharge, so the TSS within the receiving waterbody (i.e., just downstream of the hatchery discharge point) would be less due to dilution (ICF 2010). The range of potential suspended material in Fall Creek Hatchery discharges would likely be similar to existing CDFW hatcheries, so the potential for hatchery discharges to cause nuisance or adversely affect beneficial uses by introducing suspended material, settleable material, or sediments in excess is based on data regarding existing hatcheries. In line with data from existing CDFW hatcheries and expected dilution in the receiving waterbodies, suspended material in hatchery discharges would remain below the numeric SSC[74] threshold of significance for suspended sediments. Thus, Fall Creek Hatchery discharges under the Proposed Project would have a less than significant impact on suspended sediments in the short term and long term in Fall Creek and in the Klamath River downstream of its confluence with Fall Creek.

Nutrient concentrations in hatchery discharges likely would increase nutrients in Fall Creek downstream of the settling ponds and to a lesser extent downstream of the adult fish ladder, based on nutrient data from existing CDFW hatcheries. In the six existing CDFW hatcheries with nutrient data, the measured nutrients ranged from 0.07 to 5.6 mg/L TN, 0.008 to 5.2 mg/L nitrate, 0.02 to 0.25 mg/L TP, and less than 0.01 to 0.28 mg/L orthophosphate (ICF 2010). The range of measured nitrate concentrations indicates that there is no potential for hatchery discharges to exceed nitrate primary

[74] For the purposes of this report, SSC is considered equivalent to TSS (see Section 3.2.3.1 *Thresholds of Significance* for additional details).

drinking water standards in streams. The existing CDFW hatchery data also documents that nutrient concentrations in hatchery discharges usually vary little from nutrient concentrations in the hatchery source water (i.e., upstream water not influenced by the hatchery), with higher nutrient concentrations in hatchery discharges occurring infrequently. Visual observations from 10 hatcheries that record potential nuisance growth conditions in receiving waters (i.e., streams) did not note nuisance biostimulatory responses, such as discoloration, bottom deposits, visible films/sheens, or objectionable growth (i.e., fungi or slimes) downstream of hatchery discharges (ICF 2010). Fall Creek Hatchery discharges likely would increase nutrient concentrations in Fall Creek[75] and in the Klamath River downstream of its confluence with Fall Creek, but those increases would not be expected to result in exceedances of North Coast Regional Board Basin Plan water quality objectives for biostimulatory substances.

Fall Creek Hatchery discharges may also alter dissolved oxygen in streams by discharging water with dissolved oxygen concentrations different than the receiving waters due to fish respiration or biochemical oxygen demand (BOD) from organic solids, discharging water with organic solids that contribute BOD to streams and reduces dissolved oxygen downstream of the hatchery, and biological growth (e.g., algae and bacteria) in the hatchery and settling ponds. The analysis of dissolved oxygen data from existing CDFW hatcheries, including Iron Gate Hatchery, does not present dissolved oxygen percent saturation in the hatchery discharges, so it is not possible to evaluate hatchery discharges relative to Basin Plan dissolved oxygen water quality objectives. Dissolved oxygen in existing CDFW hatchery discharges usually were greater than 7.0 mg/L, but eight hatcheries had at least one occurrence of dissolved oxygen less than 7.0 mg/L (ICF 2010). In two out of nine measurements, Iron Gate Hatchery discharge dissolved oxygen was less than 7.0 mg/L, with the minimum dissolved oxygen reaching 6.3 mg/L (ICF 2010). While hatcheries manage dissolved oxygen concentrations for fish using flow control, passive aeration devices, and mechanical aeration, there is a low potential for dissolved oxygen below 7.0 mg/L (ICF 2010) that may correspond to dissolved oxygen percent saturation being less than Basin Plan dissolved oxygen water quality objectives. Dissolved oxygen percent saturation varies with water temperature, so dissolved oxygen can be below 7.0 mg/L during peak summer water temperature conditions, yet still meet the Basin Plan dissolved oxygen water quality objectives of 85 percent saturation. Thus, Fall Creek Hatchery discharges would have a low potential for causing dissolved oxygen percent saturation to be less than Basin Plan dissolved oxygen water quality objectives in Fall Creek downstream of the hatchery or in the Klamath River downstream of the confluence with Fall Creek.

While Fall Creek Hatchery discharges would have a low potential for causing dissolved oxygen percent saturation to become less than Basin Plan dissolved oxygen water quality objectives, dissolved oxygen percent saturation in Fall Creek may infrequently decrease below Basin Plan dissolved oxygen water quality objectives and thus there would be significant impact without mitigation on dissolved oxygen in the short term and long term from hatchery discharges under the Proposed Project.

[75] One data point exists for nutrient concentrations in Fall Creek measured in October 1999 when the Fall Creek Hatchery was still in operation. However, due to the difference in production goals and proposed new facilities (i.e., settling ponds), it is likely this data would overestimate background nutrient conditions in Fall Creek and potentially overestimate nutrient conditions in Fall Creek upon the resuming of Fall Creek Hatchery operations.

Fall Creek Hatchery discharges are unlikely to alter pH in streams based on pH monitoring data from existing CDFW hatcheries. The incremental change in pH between upstream and downstream monitoring data was less than 0.5 s.u. downstream of all hatcheries where downstream pH data was available (ICF 2010). Hatchery discharges had pH greater than 8.5 s.u. or less than 6.5 s.u. in only four out of the 12 CDFW hatcheries, with no exceedances occurring at Iron Gate Hatchery (ICF 2010). Thus, Fall Creek Hatchery discharges under the Proposed Project would be unlikely to alter pH in Fall Creek or the Klamath River downstream of its confluence with Fall Creek by 0.5 s.u. or more or result in pH less than 6.5 units or greater than 8.5 units and there would be a less than significant impact without mitigation on pH in Fall Creek and the Klamath River due to Fall Creek Hatchery operations and discharges under the Proposed Project.

Fall Creek Hatchery discharges would potentially increase the concentration of inorganic and organic contaminants in Fall Creek downstream of the settling ponds due to the use of water treatment chemicals, drugs, and vaccines to treat illnesses within hatchery fish (i.e., therapeutics) or prevent detrimental fungal or bacterial conditions. Chemical use in hatcheries typically occurs for several hours using immersion bath or flushing water through one or more components of the hatchery facilities for general treatments, while therapeutics are usually applied in small water volumes or fish feed for a short duration of several minutes up to one hour (ICF 2010). All water from the rearing ponds after cleaning, feeding, or therapeutic use along with all water from the incubation and spawning operations would be discharged from the hatchery settling pond (Figure 2.7-15), so potential increases in inorganic and organic contaminants would be limited to downstream of the settling pond (maximum of approximately 0.35 miles upstream of Fall Creek's confluence with the Klamath River).

Potential chemicals used in CDFW hatcheries, the reason for their use, and the regulatory status of the chemicals are summarized in Table 3.2-15. Copper sulfate had been historically used in hatcheries for general treatments, but its use has been discontinued in all CDFW hatcheries (ICF 2010). All the chemicals currently used are Food and Drug Administration (FDA) Center Veterinary Medicine (CVM) approved, investigational new animal drugs (INAD), low regulatory priority (LRP) compounds, or deferred decision (DD) chemicals (Table 3.2-15). FDA approved drugs have been determined to be safe for the treated fish, humans who might consume the treated fish, and the environment when used in accordance with label instructions for proper usage. FDA INAD are used under exemption only, with annual renewals and numerous FDA requirements for their use. FDA LRP compounds are considered comparatively little risk to aquatic organisms, human consumers, or the environment, such that regulatory action is unlikely to occur as long as an appropriate grade of the compound is used for listed indications at the prescribed levels according to good management practices and local environmental requirements are met. FDA DD chemicals are those already approved by the USEPA in aquaculture settings (AFS FCS 2014).

Table 3.2-15. Potential General Treatment and Therapeutic Chemicals Used at California Department of Fish and Wildlife Hatcheries.

Chemical Name	Use	Regulatory Status
acetic acid	Control of external parasites	FDA LRP compound
carbon dioxide (gas)	Anesthetic	FDA LRP compound
sodium bicarbonate (baking soda)	Anesthetic	FDA LRP compound
formalin (formaldehyde)	Fungus and parasite treatment	FDA approved
povidone-iodine (PVP iodine)	Disinfectant for eggs	FDA LRP compound
potassium permanganate	Control of external parasites and bacteria	FDA DD chemical; USEPA registered pesticide with approved use in aquaculture
hydrogen peroxide	Control of fungal and bacterial infection	FDA approved
Chloramine-T (*N*-chloro tosylamide)	Control of external gill bacteria	FDA INAD
Terramycin (oxytetracycline)	Antibiotic	FDA approved
Aquaflor (florfenicol)	Antibiotic	FDA approved
penicillin G	Control and prevention bacterial infections	FDA approved
Romet-30 (sulfadimethoxine-ormetoprim)	Antibiotic	FDA approved
MS-222 (tricane mesylate)	Anesthetic	FDA approved

Source: ICF 2010.
Notes:
FDA = Food and Drug Administration
INAD = investigational new animal drugs
LRP = low regulatory priority
DD = deferred decision
USEPA = U.S. Environmental Protection Agency

The potential for chemical concentrations in hatchery discharges to exceed the Basin Plan narrative toxicity water quality objective (Table 3.2-4), drinking water criteria, including California Department of Public Health (DPH) maximum contaminant levels (MCLs), or otherwise degrade water quality in streams was evaluated for existing CDFW hatcheries by comparing chemical use concentrations and measurements of chemicals in undiluted hatchery discharge water with CDFW Pesticide Unit guidance aquatic toxicity values and a CDFW Pesticide Investigation Unit toxicity assessment that determined short-term acute test methods (i.e., lethality end point) and chronic test methods (i.e., growth and reproduction end point) (ICF 2010). The CDFW Pesticide Investigation Unit toxicity assessment has been used previously by Regional Water Quality Control Boards to develop NPDES permit numerical effluent limits considered protective of applicable narrative toxicity objectives. Based on the frequency and duration of use in hatcheries, the expected rate of dilution and degradation in the environment, and reported hatchery discharge concentrations, the ICF (2010) analysis concludes acetic acid, carbon dioxide, sodium bicarbonate, PVP iodine, oxytetracycline, florfenicol, penicillin G, Romet-30, and MS-222 all pose a low risk of exceeding CDFW guidance values that are protective of aquatic life, thus the potential for substantial adverse effects on human health or environmental receptors is very low. Available data indicates formalin, potassium permanganate, hydrogen peroxide, and Chloramine-T may exceed CDFW guidance values in undiluted hatchery water, but the analysis concludes the potential for substantial adverse effects from these chemicals on aquatic life-related beneficial uses and other less sensitive designated beneficial uses is very low since potentially elevated concentrations of the chemicals in undiluted hatchery discharges would be expected to rapidly degrade in the aquatic environment, or be diluted within the zone of complete mixing in the receiving waters (ICF 2010). As the discharge will be downstream of the City of Yreka's Fall Creek diversion for drinking water, the discharge should pose no risk to that water supply.

Fall Creek Hatchery operations and general treatment or therapeutic chemical use would be expected to be generally similar in the short term and long term to other CDFW hatcheries. Installation of an ultraviolet light (UV) treatment system for water used in egg incubation at Fall Creek Hatchery, as specified for the Proposed Project, would likely reduce chemical use relative to other CDFW hatcheries without UV treatment systems. Additionally, potential influences of hatchery discharges on Fall Creek and the Klamath River downstream of its confluence with Fall Creek would occur for eight years (i.e., dam removal year 2 and the subsequent seven years post-dam removal) since Fall Creek Hatchery is assumed to operate for only this duration under the Proposed Project. Thus, potential increases in inorganic and organic contaminants in Fall Creek and in the Klamath River downstream of its confluence with Fall Creek due to general treatment or therapeutic chemicals in Fall Creek Hatchery discharges also would have a low risk of substantially adversely impacting aquatic life or other designated beneficial uses in the short term and long term and there is a less than significant impact without mitigation on inorganic and organic contaminants in the short term and long term under the Proposed Project from Fall Creek Hatchery discharges.

In summary, the combined impact of Fall Creek and Iron Gate hatchery operations under the Proposed Project would have no significant impact below Iron Gate Hatchery's discharges, since production would be reduced, decreasing impacts on Klamath River water quality from hatchery operations relative to existing conditions. Fall Creek Hatchery would have a significant impact without mitigation on water temperature in Fall Creek and potentially the Klamath River as it would potentially alter water temperature by -0.5 to 2.2ºF and any increase in water temperature would exceed the Thermal Plan water temperature water quality standard for **COLD** interstate waters. Dissolved oxygen percent saturation in Fall Creek may infrequently occur at levels below Basin Plan dissolved oxygen water quality objectives due to Fall Creek Hatchery discharges and thus there would be significant impact without mitigation on dissolved oxygen in the short term and long term from hatchery discharges under the Proposed Project. While Fall Creek Hatchery operations and discharges would alter suspended materials, and inorganic and organic contaminant concentrations downstream of hatchery discharges, there would be no significant impact on suspended sediments, pH, chlorophyll-a and algal toxins, or inorganic or inorganic and organic contaminants in Fall Creek or the Klamath River downstream of Fall Creek in the short term or long-term under the Proposed Project.

In order to comply with Sections 301, 302, 303, 306, and 307 of the Clean Water Act (CWA), and with applicable requirements of California law, the Proposed Project would implement the conditions specified by the State Water Board in the Section 401 water quality certification. In addition to the Proposed Project Fish Hatchery Plan (see also Section 2.7.6; Appendix B: *Definite Plan – Section 7.8.3 Proposed Fish Hatchery Plan*), the draft water quality certification issued by the State Water Board specifies in

Condition 12 *Hatcheries* that, prior to operation of the Iron Gate and Fall Creek hatcheries, the Licensee shall, for each hatchery, obtain coverage under and comply with the *Cold Water Concentrated Aquatic Animal Production Facility Discharges to Surface Waters, National Pollutant Discharge Elimination System* permit (NPDES No. 135001) or subsequent NPDES permits issued by the North Coast Regional Board.

Several measures were considered to remediate water temperature increases in Fall Creek to avoid a significant impact. Fall Creek Hatchery settling pond and adult fish ladder discharges directly from Fall Creek diversion point could discharge to the Klamath River rather than Fall Creek. Fall Creek is typically cooler than the Klamath River, so Fall Creek Hatchery settling pond discharges would likely still be cooler than the Klamath River even with small amounts of warming of Fall Creek water through the hatchery. Thus, redirecting Fall Creek Hatchery settling pond discharges from Fall Creek to the Klamath River likely would not increase the temperature of interstate waters. Adult fish ladder discharges under the Proposed Project would have gone through the rearing ponds, so they may experience some warming and they may also increase the temperature of interstate waters. Thus, the adult fish ladder discharges would also need to be re-plumbed such that adult fish ladder discharges would be directly taken from the Fall Creek Hatchery diversion point on the Fall Creek powerhouse canal return flow to prevent warming. It is unclear given the available information about the plumbing of the Fall Creek Hatchery whether diverting flows from the Fall Creek Hatchery diversion point directly to the adult fish ladder and having all flows for the rearing tanks go to the settling pond for eventual discharge directly to the Klamath River is even generally feasible or cost-effective (i.e., this distance of pipe is unlikely to be cost effective for temporary hatchery modifications. Additionally, due to prolific tribal cultural resources in the vicinity of Fall Creek Hatchery this measure is likely infeasible. Furthermore, diverting flows from Fall Creek would reduce high-quality habitat for anadromous fish spawning for a longer stretch of the creek. Thus, this measure was not pursued as a feasible mitigation measure.

Chillers may also reduce water temperatures in Fall Creek Hatchery discharges so that water temperature in discharges is always less than the water temperature of receiving waters (in this case, Fall Creek). However, the temporary operations of the hatchery combined with the electricity cost of a chiller(s) was, like the distance for additional piping, found not to be feasible, and this mitigation measure was likewise not pursued.

Significance

No significant impact in the short term and long term for water quality in the Middle Klamath River downstream of Iron Gate Hatchery

Significant and unavoidable in the short term for water temperature and dissolved oxygen in Fall Creek downstream of Fall Creek Hatchery

No significant impact in the long term for water quality (except water temperature and dissolved oxygen) in Fall Creek downstream of Fall Creek Hatchery

Potential Impact 3.2-18 Impacts on water quality from construction activities on Parcel B lands.

As discussed in Section 2.7-10 *Land Disposition and Transfer*, as part of the Proposed Project, Parcel B lands would be transferred to the states (i.e., California and Oregon), as applicable, or to a designated third-party transferee, following dam removal. The outcome of the future Parcel B land transfer is speculative with regard to land use; while the lands would be managed for the public interest, this could include open space, active wetland and riverine restoration, river-based recreation, grazing, and potentially other uses.

It is likely that there would be at least some construction for recreation facilities, active restoration, fencing, trail-building, or other land management activities. To the extent there are construction activities, these could involve the same types of potential short-term impacts to water quality as described in Potential Impact 3.2-4, which would be a significant impact. Use of construction best management practices are feasible and implementation of these can reduce the erosion and sediment issues associated with construction to less than significant.

Therefore, the impact of minor construction on suspended sediments in the future associated the transfer of Parcel B lands and future land use on them would be less than significant with mitigation measures WQ-1, TER-1, and HZ-1, which include BMPs for the area. These measures represent protection under a broad range of construction projects, both in-water and in the dry, and are likely to cover the range of construction activities that would support the various public land uses anticipated under the KHSA. If implemented as part of construction activities under future land uses, these measures would avoid potential violations of water quality standards or other water quality degradation in affected portions of wetlands and other waterbodies and would reduce impacts to less than significant.

In the long term, if managed grazing activities were to occur beyond the level occurring under existing conditions, this could result in erosion-related significant impacts on water quality. However, managed grazing activities would incorporate project-specific measures to reduce potential water quality impacts, including storm water management, streambank setbacks, or exclusionary livestock fencing. Managed grazing activities are required to meet the requirements of the non-point source discharge policy, the prohibition against unpermitted discharges, and the North Coast Regional Water Quality Control Board's Agricultural Lands Discharge Program. These require compliance with BMPs designed to meet state water quality requirements (North Coast Regional Board 2018a). Managed grazing activities that implement such project-specific measures would be expected to have a less than significant impact on water quality in the long term. Future land use activities that involve active wetland and riverine restoration would be likely to result in long-term benefits to water quality.

Significance

No significant impact with mitigation in the short term or long term

3.2.6 References

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3.3 Aquatic Resources

This section describes existing conditions of aquatic resources in the Klamath Basin; analyzes potential impacts that the Proposed Project would have on these aquatic resources and the recovery of listed fish species; and includes measures to avoid or mitigate any significant adverse impacts to fish, aquatic mammals, freshwater mussels, and aquatic macroinvertebrates. Commercial fisheries are discussed in Section 5.3.1 *Regional Economic Impacts*, and potential impacts to recreational fisheries opportunities are in discussed Section 3.20 *Recreation*. The tribal significance of fisheries and potential impacts are discussed in Section 3.12 *Historical Resources and Tribal Cultural Resources*. Floating and attached algae are addressed in Section 3.4 *Phytoplankton and Periphyton*, and wetlands and riparian vegetation and wildlife species (including amphibians and reptiles) are addressed in Section 3.5 *Terrestrial Resources*.

The objectives of the Proposed Project include advancing the long-term restoration of the natural fish populations in the Klamath Basin through water quality improvements, habitat expansion, and a reduction in existing disease rates among salmonids (Section 2.1 *Project Objectives*). Many comments were received by the State Water Board during the public scoping process relating to aquatic resources (see Appendix A), and several of the comment topics were controversial. Some commenters expressed concern that the Proposed Project will not, or is not likely to, meet the stated objectives, or that the costs of implementation (financial and otherwise) are too great to justify the potential for gain. Numerous commenters asserted that hundreds of miles of habitat would become available to salmonids should the dams be removed, and many commenters asserted evidence of historical salmon migrations to Upper Klamath Lake. In contrast, a number of comments identified potential fish passage obstructions located within the portion of the mainstem Klamath River that is currently inundated by the Lower Klamath Project reservoirs. Many comments further stated the belief that coho salmon were not historically found in the Klamath Basin, while others stated that coho salmon were not found in the mid- or upper Klamath Basin due to natural passage barriers. Numerous comments described the fishery benefits that could result from dam removal, including increased habitat access and reduced fish disease, while other comments described the fishery benefits that could result from leaving the dams in place and using fish ladders to support passage and hatchery operations to offset habitat losses. Many public comments contended that the Lower Klamath Project dams are responsible for the reduction in salmon populations in the Klamath Basin, while a roughly equal number of comments indicated that other factors are responsible for the observed population declines, including predation by sea lions, tribal harvest, and fishing pressure from foreign fishing fleets. Comments were also received regarding the relationship between marine mammals, such as Southern Resident Killer Whales and sea lions, and the Chinook salmon fishery in the Klamath watershed, including comments that dam removal could benefit the mammals by increasing abundance of their prey. Additional summary of the aquatic resource comments received during the public scoping process, as well as the individual comments, are presented in Appendix A.

3.3.1 Area of Analysis

The Area of Analysis for aquatic resources considers the range of environments that could be affected by the Proposed Project. The Area of Analysis includes most portions of the Klamath Basin, excluding the Lost River watershed, and most of the Trinity River.

Although the Area of Analysis for aquatic resources includes much of the Upper Klamath Basin in Oregon, these areas are included only to the extent to which they affect California aquatic resources. As the lower 1/4 to 1/2 mile of the Trinity River could be used as a refuge by Klamath River fish attempting to avoid exposure to sediment pulses associated with dam removal, this portion of the Trinity River is also considered in the analysis as part of the Klamath Basin, the Area of Analysis includes the Klamath River Estuary and the nearshore portions of the Pacific Ocean.

This aquatic resources analysis includes an assessment of potential impacts within and across five study reaches of the Klamath River separated by changes in basin physiography (e.g., Upper and Lower Klamath basins), the presence of Lower Klamath Project facilities, and the degree of marine influence (Figure 3.3-1). The five study reaches within the Area of Analysis for aquatic resources are as follows:

1. Upper Klamath River and Connected Waterbodies
    a. Tributaries to Upper Klamath Lake (Sprague, Wood, and Williamson rivers)
    b. Upper Klamath Lake and Agency Lake
    c. Keno Impoundment/Lake Ewauna
    d. Upper Klamath River upstream of the influence of J.C. Boyle Reservoir to Keno Dam
    e. Tule Lake and Lost River between Anderson Rose Dam and Tule Lake
2. Upper Klamath River − Hydroelectric Reach
    a. J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate reservoirs
    b. J.C. Boyle Bypass and Peaking reaches
    c. Copco No. 2 Bypass Channel
    d. Tributaries to the Upper Klamath River (e.g., Jenny, Spencer, Shovel, and Fall creeks)
3. Middle and Lower Klamath River
    a. Middle Klamath River from Iron Gate Dam downstream to the confluence with Trinity River
    b. Major tributaries to the Middle Klamath River (e.g., Shasta, Scott, and Salmon Rivers)
    c. Minor tributaries to the Middle Klamath River (e.g., Bogus, Beaver, Humbug, and Cottonwood creeks)
    d. Lower Klamath River from the confluence with the Trinity River to the estuary
    e. Lower portion of the Trinity River
4. Klamath River Estuary
5. Pacific Ocean Nearshore Environment
    a. California portion of the Klamath River Management Zone (KMZ, Oregon-California state line south to Horse Mountain [40° 05’ 00” N. latitude])

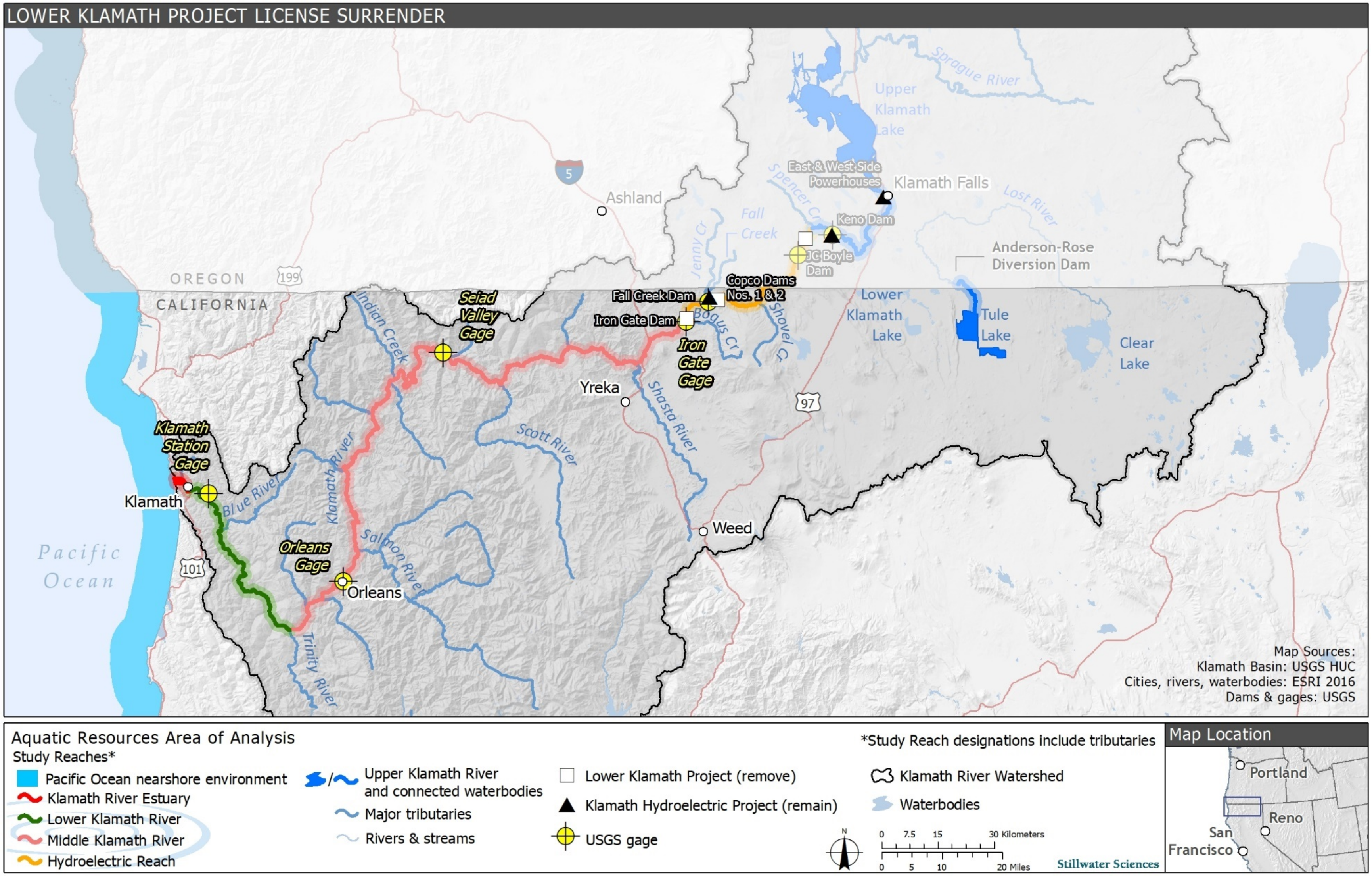

Figure 3.3-1. Study Reaches within the Area of Analysis for Aquatic Resources.

3.3.2 Environmental Setting

This section describes existing conditions in the Area of Analysis for aquatic resources, including discussion of aquatic species (Section 3.3.2.1 *Aquatic Species*); physical habitat in the waterbodies (Section 3.3.2.2 *Physical Habitat Descriptions*); and important factors affecting aquatic resources that the Proposed Project would influence, if implemented (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*).

Each aquatic species description includes a brief summary of the current and historical distribution, life-history patterns, and habitat requirements. The narrative is subdivided into anadromous fish, resident riverine fish, non-native fish species, estuarine species, freshwater mollusks, benthic macroinvertebrates, and marine mammals.

The description of physical habitat contains a summary of water quality and other factors that may limit aquatic resource production in the waterbodies in the Area of Analysis, and it describes the species that occur in the California portion of these waterbodies. This section also describes designated critical habitat for species listed under the federal ESA and Essential Fish Habitat (EFH) managed under the Magnuson-Stevens Fishery Conservation and Management Act occurring within the California portion of the aquatic resources Area of Analysis.

Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project* provides a more detailed description of existing conditions for factors that potentially could have a major influence on aquatic resources. These factors form the basis for Section 3.3.5 *[Aquatic Resources] Potential Impacts and Mitigation*.

3.3.2.1 Aquatic Species

Numerous aquatic species use the California portion of the Klamath Basin during some or all of their lives. The large number of species prohibits an individual evaluation of each species. Instead, the assessment of potential impacts and/or benefits of the Proposed Project within California on aquatic species is based on an analysis of target species that possess a legal status or importance for tribal, commercial, or recreational fisheries, and for which there are sufficient data to support the analysis. Appendix J: *Special-status Plant, Fish, and Wildlife Scoping Lists* Table J-1 includes a summary of all special-status aquatic fish documented in the Project vicinity. Special status species included in the analysis are summarized in Table 3.3-1, and all the target species (including others without special status) selected for analysis are discussed below.

Table 3.3-1. Special-status Aquatic Species Documented in the Vicinity of the Proposed Project and Included in Aquatic Resources Analysis.

Common Name ***Scientific Name***	**Status[a] Federal/ State/Forest Service, Bureau of Land Management**	**Query Sources**	**Distribution**	**Habitat Association**
Fish				
Shortnose sucker *Chasmistes brevirostris*	FE/SE, SFP/-- Designated critical habitat	CNDDB USFWS	Resident fish observed in the Upper Klamath Basin. In California, they are found in the Klamath River downstream to Copco No. 1 Reservoir and Iron Gate Reservoir.	Warm slow-moving waters or lakes. Spawning occurs along shorelines of lakes or tributaries.
Lost River sucker *Deltistes luxatus*	FE/SE, SFP Designated critical habitat within Area of Analysis	CNDDB USFWS	Resident fish observed in the Upper Klamath Basin. In California, they are found in the Klamath River downstream to Copco No. 1 Reservoir and Iron Gate Reservoir.	Warm slow-moving waters or lakes. Spawning occurs along shorelines of lakes or tributaries.
Coho salmon, southern Oregon/northern California coasts ESU *Oncorhynchus kisutch*	FT/ST/-- Designated critical habitat within Area of Analysis	USFWS	Within the Area of Analysis anadromous fish occurring downstream in the mainstem Klamath River and tributaries downstream of Iron Gate Dam	Streams; spawns in gravel riffles
Chinook salmon - upper Klamath and Trinity Rivers ESU *Oncorhynchus tshawytscha*	--/SSC/FSS	CNDDB	Within the Area of Analysis anadromous fish occurring downstream in the mainstem Klamath River and tributaries downstream of Iron Gate Dam	Streams; spawns in gravel riffles
Coastal cutthroat trout *Oncorhynchus clarki*	--/SSC/FSS	CNDDB	Within the Area of Analysis coastal cutthroat trout are distributed primarily within smaller tributaries to the lower 22 miles of the Klamath River mainstem above the estuary, but also within tributaries to the Trinity River.	Shaded streams with water temperatures below 64.4˚F and small gravel for spawning
Summer-run steelhead trout *Oncorhynchus mykiss irideus*	--/SSC/--	CNDDB	Within the Area of Analysis anadromous fish distributed throughout the Klamath River and in its tributaries, downstream from Iron Gate Dam	Streams; spawns in gravel riffles
Longfin smelt *Spirinchus thaleichthys*	FC/ST, SSC/--	CNDDB	Within the Area of Analysis anadromous fish found in Klamath River Estuary	Adults in large bays, estuaries, and nearshore coastal areas; migrate into freshwater rivers to spawn; salinities of 15–30 ppt

Common Name *Scientific Name*	Status[a] Federal/ State/Forest Service, Bureau of Land Management	Query Sources	Distribution	Habitat Association
Eulachon *Thaleichthys pacificus*	FT/--/-- Designated critical habitat within Area of Analysis	CNDDB	Within the Area of Analysis anadromous fish found in Klamath River Estuary	Adults in large bays, estuaries, and nearshore coastal areas; migrate into freshwater rivers to spawn.
Aquatic Mollusks				
Montane peaclam *Pisidium ultramontanum*	–/–/FSS	CNDDB	Within the Area of Analysis, they have been found in Upper and Lower Klamath Basin	Mollusk found in spring-influenced streams, lakes, and pools and strongly associated with sands or small clean gravels
Mammals				
Killer whale *Orcinus orca* Southern Resident DPS	FE/– Critical habitat (Designated)	NMFS	Pacific Ocean	Coastal habitats of temperate waters, including bays

[a] Status codes:

Federal
FE = Listed as endangered under the federal Endangered Species Act
FT = Listed as threatened under the federal Endangered Species Act
FPE = Federally proposed as endangered
FPT = Federally proposed as threatened
FC = Federal candidate species
FD = Federally delisted
PD = Federally proposed for delisting
BGEPA = Federally protected under the Bald and Golden Eagle Protection Act
FSS = Forest Service Sensitive species
BLMS = Bureau of Land Management Sensitive Species

State
SE = Listed as Endangered under the California Endangered Species Act
ST = Listed as Threatened under the California Endangered Species Act
SCE = State Candidate Endangered
SD = State Delisted
SSC = CDFW Species of Special Concern
SFP = CDFW Fully Protected species
BOFS = Considered a sensitive species by the California Board of Forestry under the California Forest Practice Rules (14 CCR §895.1)

Fish

Numerous fish species use the California portion of the Klamath Basin during some portion or all of their lives. Native fishes found in riverine environments, some of which are listed under the federal or state ESAs, include salmonids, lamprey, sturgeon, suckers, minnows, dace, sculpin; and in the estuary, anchovy, gunnel, pipefish, eulachon, smelt, stickleback, and gobies occur. Species that have been introduced into the Klamath Basin include non-native yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), spotted bass (*Micropterus punctulatus*), sunfish (*Lepomis spp*), and catfish (*Siluriformes spp*).

Anadromous Fish Species

The Klamath Basin provides habitat for many species of anadromous fish – fish that migrate between salt and fresh water. Many Klamath River anadromous fish are salmonids, but there are also green sturgeon (*Acipenser medirostris*), Pacific lamprey (*Entosphenus tridentatus*), American shad (*Alosa sapidissima*) (discussed under *Non-native Fish Species* below), and eulachon (*Thaleichthys pacificus*) (discussed under *Estuarine Species* below). Additionally, CDFW operates the Iron Gate Hatchery directly downstream of Iron Gate Dam for salmonid production, as described in more detail in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project – Fish Hatcheries*.

Anadromous fish species within the Klamath Basin have nearly all declined compared to their historical abundance (Table 3.3-2). Although historical data are not available for green sturgeon, the population appears to be more stable than other fish species. Based on reports of green sturgeon captures in the Yurok Tribal Chinook salmon gill-net fishery, Van Eenennaam et al. (2006) conditionally suggests that the Klamath River green sturgeon population appears strong and stable but cautions against conclusions based on short time frames relative to the green sturgeon's long-life span.

Table 3.3-2. Historical and Recent Status of Klamath River Anadromous Fish.

Species	Historical Run Estimate[1]	Recent Run Size Estimate	Source
Pacific Lamprey			
Basin Wide	N/A	4,750–13,000[2]	Goodman and Reid 2012
Shasta River	N/A	250–1,000[2]	Goodman and Reid 2012
Scott River	N/A	250–1,000[2]	Goodman and Reid 2012
Salmon River	N/A	1,000–2,500[2]	Goodman and Reid 2012
Trinity River	N/A	2,000–5,000[2]	Goodman and Reid 2012
Steelhead			
Basin Wide	400,000[3]	Summer – 110,000[4] Winter – 20,000[4]	Historical (Leidy and Leidy 1984) Recent (Busby et al. 1994)
Scott River	N/A	146–419[5]	CDFW 2013
Trinity River (wild spawners)	N/A	2,454–9,205[6]	CDFW 2016a
Trinity River Hatchery[5]	N/A	4,460–46,379[6]	CDFW 2016a

Species	Historical Run Estimate[1]	Recent Run Size Estimate	Source
Iron Gate Hatchery	N/A	<100–631	CA HSRG 2012 CDFW 2018c
Coho Salmon			
Basin Wide	15,400–20,000	973 to 14,650[8]	Historical (Moyle et al. 1995) Recent (Ackerman et al. 2006)
Iron Gate Hatchery (spawners)	N/A	70–1,734[9]	CDFW 2015a
Bogus Creek (spawners)	N/A	6–409[5]	CDFW 2015a
Shasta River (spawners)	N/A	9–373[5]	CDFW 2015a
Scott River	N/A	63–1,622[5]	CDFW 2013
Trinity River (wild spawners)	N/A	645–4,457[6]	CDFW 2016a
Trinity River Hatchery[7]	N/A	3,805-18,454[6]	CDFW 2016a
Fall-Run Chinook Salmon			
Basin Wide	500,000	27,369–316,754[6,10]	Historical (Moyle 2002) Recent (CDFW 2017)
Bogus Creek (spawners)	N/A	2,353–12,930[6]	CDFW 2017
Salmon River (spawners)	N/A	1,432–5,493[6]	CDFW 2017
Scott River (spawners)	N/A	1,515–12,470[6]	CDFW 2017
Shasta River[9] (spawners)	20,000–80,000	1,348–29,544[6]	Historical (Moyle 2002) Recent (CDFW 2017)
Trinity River (wild spawners)	N/A	5,834–47,944[6]	CDFW 2016a, CDFW 2017
Trinity River Hatchery	N/A	4,531–32,875[6]	CDFW 2016a, CDFW 2017
Iron Gate Hatchery (spawners)	N/A	8,176–40,015[6]	CDFW 2017

Species	Historical Run Estimate[1]	Recent Run Size Estimate	Source
Spring-Run Chinook Salmon			
Basin Wide (Run size)	100,000	11,930–35,082[10,11]	Historical (Moyle 2002) Recent (CDFW 2015b)
Salmon River (spawners)	N/A	90–1,593[11]	CDFW 2015b
Trinity River (wild spawners)	N/A	5,382–22,727[11]	CDFW 2015b
Trinity River Hatchery (spawners)	N/A	2,578–6,990[11]	CDFW 2015b
Green Sturgeon			
Basin-wide	Unknown	Unknown[12]	Adams et al. 2007
Coastal cutthroat			
Basin-wide	Unknown	Unknown, but likely stable to increasing[13]	Moyle et al. 2017

N/A: Not available.
[1] "Historical" is considered pre-1900's, unless otherwise noted.
[2] Based on data from 2009–2012
[3] Estimate from 1960. Anadromous fish numbers were already in decline in the early 1900s (Snyder 1931)
[4] Based on data from 1977–1991
[5] Based on data from 2007–2012
[6] Based on data from 2006–2015
[7] Trinity River Hatchery steelhead includes hatchery returns and hatchery origin fish that spawn in the wild
[8] Based on data from 1999–2005
[9] Based on data from 2004–2012
[10] Run size includes hatchery returns
[11] Based on data from 2005–2015
[12] Klamath River has the largest spawning population in the ESU, but while harvest numbers are available, no populations estimates have been made.
[13] Coastal cutthroat are present in lower Klamath tributaries, but no population numbers are available.

Anadromous Salmonids

Anadromous salmonids in the Klamath River include fall-run[76] and spring-run Chinook salmon (*Oncorhynchus tshawytscha*); coho salmon (*Oncorhynchus kisutch*); fall-, winter-, and summer-run steelhead (*Oncorhynchus mykiss*); and coastal cutthroat trout (*Oncorhynchus clarki clarki)*. Anadromous salmonids share similar life-history traits, but the timing of their upstream migrations, timing of outmigration[77], habitat preferences, and distributions differ. All anadromous salmonids spawn in gravel or cobble substrates that are relatively free of fine sediment with suitable surface and subsurface flow to carry oxygen to the eggs and carry metabolic waste away from the eggs. Once suitable spawning habitat is found, the adult female digs one or more nests (called redds) and deposits up to 3,000 eggs per redd (depending on species). The larger the female, the greater the number of eggs she produces. Her mate, or mates, will simultaneously

[76] Run is a migration of salmon up a river from the sea.
[77] Outmigration is the migration of juvenile salmonids from rivers downstream to the estuary and ocean.

fertilize the eggs and fend off other males and egg-eating predators. The female continues digging upstream of the nest, which forms a distinctive pit just upstream from and a protective mound of gravel and cobble over the eggs. The female will continue the mound-building process and defend her nest location. Most anadromous male and female salmonids die after completing spawning, although steelhead and coastal cutthroat may survive spawning, re-enter the ocean, and return to spawn the following year(s).

The salmonid eggs hatch several weeks or months after spawning, depending on species and water temperature. The resulting yolk-sac fry, also referred to as alevins, reside in the gravel for several more weeks and feed off their yolk sac until it is depleted. Egg-to-emergence survival is related to fine sediment infiltration, water temperature, and the fitness of the eggs. The fry that survive to emerge from the redds seek slow shallow areas near shoreline or vegetative cover, feed on benthic macroinvertebrates, gradually moving into deeper and faster water as they grow. Anadromous salmonids are generally considered "juveniles" when they have grown to a fork length of approximately 55 millimeters (about 2.2 inches)[78].

Juveniles feed opportunistically on macroinvertebrates, crustaceans, and smaller fish, and grow on their way downstream. Downstream migration is increased during spring rain events. As discussed in detail in subsequent sections, survival of fry and juvenile life stages is related to disease, parasites, food availability, predation risk, water temperature, and habitat availability (e.g., refuge from high flows). Within the Klamath River juvenile salmonids seek refuge from high flows and turbidity during winter in off-channel features such as side-channels and ponds, and during summer locate thermal refuge within cool water at the confluence with tributaries (in addition to thermal relief during nighttime cooling). Juvenile salmonids may also rear for some time in the estuary feeding prior to entering the ocean. Before entering brackish or salt water, juveniles must undergo a physiological process called smoltification, which is the series of physiological changes allowing juveniles to adapt from living in fresh water to living in seawater. After entering the ocean, smolts range up and down the coast as they grow to adulthood.

Most adult salmonids return to spawn in the stream where they were born, although some straying to nearby waterbodies does occur. Different salmon species and populations (and even the same populations from year to year) have highly variable straying rates, with hatchery origin spawners straying at a higher rate (Lasko et al. 2014). Straying may be the result of a multitude of factors, including as a response to environmental conditions or disturbance events, or exploration of new habitats for suitability. Survival of adults in the marine environment is related to fishing pressure, food availability, and predation risk (e.g., marine mammals). When adults return to natal streams upstream migration success is related to availability of adequate instream flows, turbidity, water temperature (for spring- and summer-runs), disease and parasites, fishing pressure, and passage obstacles (both natural and man-made). Between 1998 and 2008, smolt-to-adult-return-ratios (SAR) for coho at Iron Gate Hatchery ranged from 0.04 percent to 2.66 percent with an average of 0.99 percent (CDFW 2014). From 1988 to 2003, the SAR for fall Chinook released from the Trinity River hatchery ranged from 0.12 percent to 3.19 percent with an average of 1.61 percent (California HSRG 2012).

[78] Fork length is the length of a fish measured from the tip of the snout to the end of the middle caudal fin rays.

For Trinity River Spring Chinook, Yearling releases have averaged just over twice the survival of smolt releases (0.54 percent vs. 1.11 percent). The range of SARs for smolts was from 0.004 percent in 1989 to 2.27 percent in 1999. The SAR range for yearlings was from 0.08 percent in 1990 to 3.30 percent in 1999.

Specific details of life history and distribution are described in the following sections for each anadromous salmonid species.

Chinook Salmon

Two Chinook salmon Evolutionarily Significant Units (ESUs) currently occur in the Klamath Basin downstream of Iron Gate Dam—the Southern Oregon and Northern California Coastal ESU, which includes all naturally spawned Chinook salmon in the Lower Klamath River downstream from its confluence with the Trinity River, and the Upper Klamath and Trinity Rivers ESU, which includes all naturally spawned populations of Chinook salmon in the Klamath and Trinity rivers upstream of the confluence of the two rivers. A status review in 1999 determined that neither ESU warranted listing under the federal ESA (NMFS 1999a). The Upper Klamath and Trinity Rivers ESU is listed as a CDFW Species of Special Concern and a USDA Forest Service Sensitive Species.

Another petition to list Chinook salmon in the Upper Klamath and Trinity Rivers ESU under the ESA was submitted to NMFS in January 2011 (CBD et al. 2011). In the petition, NMFS was asked to consider one of three alternatives for the listing of Chinook salmon in the Upper Klamath and Trinity River ESU: (1) list spring-run only as a separate ESU, (2) list spring-run as a distinct population segment (DPS) within the Upper Klamath and Trinity River Chinook Salmon ESU, or (3) list the entire Chinook salmon Upper Klamath and Trinity River ESU including both spring-run and fall-run populations. In April 2011, NMFS announced that the petition contained substantial scientific information warranting federal review as to whether Chinook salmon within the Upper Klamath and Trinity River ESU should be listed as threatened or endangered. As a result, NMFS formed a Biological Review Team (BRT) to assess the biological status of the species and determine if listing under the ESA is necessary. The BRT (Williams et al. 2011) found that recent spawner abundance estimates of both fall-run and spring-run Chinook salmon returning to spawn in natural areas are generally low compared to historical estimates of abundance; however, the majority of populations have not declined in spawner abundance over the past 30 years (i.e., from the late 1970s and early 1980s to 2016) except for the Scott and Shasta rivers where there have been modest declines (Williams et al. 2011). In addition, Williams et al. (2011) found that hatchery returns did not track escapement[79] to natural spawning areas and they concluded that there has been little change in the abundance levels, trends in abundance, or population growth rates since the review conducted by Myers et al. (1998). The BRT also noted that recent abundance levels of some populations are low, especially in the context of historical abundance estimates. This was most evident with two of the three spring-run population units that were evaluated (Salmon River and South Fork Trinity River). The BRT concluded that although current levels of abundance are low when compared to historical estimates of abundance, the current abundance levels did not constitute a major risk in terms of ESU extinction.

[79] Escapement is the portion of a salmon population that does not get caught by commercial or recreational fisheries and returns to their freshwater spawning habitat or hatchery of origin.

The BRT also concluded that spring-run Chinook salmon did not warrant designation as a separate ESU or DPS within the Upper Klamath and Trinity River ESU. This finding was based in part on genetic evidence that indicates that spring-run and fall-run life histories have evolved on multiple occasions across different coastal watersheds located north and south of the Klamath River. Kinziger et al. (2008) found that there are four genetically distinct and geographically separated groups of Chinook salmon populations in the Upper Klamath and Trinity River basins; and that spring-run and fall-run Chinook salmon life histories have evolved independently, but in parallel, within both the Salmon and Trinity rivers. In addition, spring-run and fall-run populations in the Salmon River were nearly genetically indistinguishable and spring-run and fall-run populations in the South Fork Trinity River were extremely similar to each other and to Trinity River hatchery stocks. Williams et al. (2011) concluded that spring-run and fall-run Chinook salmon within the Upper Klamath and Trinity River basins are genetically similar to each other and that the two runs are not substantially reproductively isolated from each other. In addition, ocean type (ocean entry in early spring within a few months of emergence) and stream type (ocean entry during spring of their second year of life) life history strategies are exhibited by both run types, further suggesting that spring-run Chinook salmon in the Upper Klamath and Trinity River basins do not represent an important component in the evolutionary legacy of the species.

However, recently published research by Prince et al. (2017) questions the basis of treating the fall-run and spring-run Chinook salmon in the Upper Klamath and Trinity River ESU as a single ESU, which was based on overall genetic structure that is primarily defined by geography. The genomic results of Price et al. indicate that premature migration observed in spring-run Chinook salmon is defined by a single genetic variation, questioning the basis of conventional ESU designations which assume that genetic structure is primarily defined by geography.

In response to new information from Prince et al. (2017), and the overall decline of spring-run Chinook salmon, in November 2017, the Karuk Tribe and the Salmon River Watershed Council submitted a petition to NMFS to list as threatened or endangered the Upper Klamath and Trinity Rivers ESU or, alternatively, create a new ESU to describe Klamath spring-run Chinook salmon and list the new ESU as threatened or endangered under the ESA. In February 2018, NMFS announced a 90-day finding on this petition (NMFS 2018a). NMFS found that the petition presents substantial scientific information indicating the petitioned actions may be warranted. NMFS will conduct a status review of the Chinook salmon in the Upper Klamath and Trinity rivers to determine if the petitioned actions are warranted. No final decision has been published to date.

Regardless of the status of a determination on whether spring-run and fall-run Chinook salmon comprise a single ESU, these two runs have different life history strategies (NRC 2004), and therefore are considered distinct in this analysis. A more detailed discussion of the two run types is described below.

Fall-Run Chinook Salmon

Fall-run Chinook salmon are currently distributed throughout the Klamath River downstream from Iron Gate Dam. Upstream adult migration through the estuary and Lower Klamath River peaks in early September and continues through late October (Moyle 2002, FERC 2007, Strange 2008) (Table 3.3-3). Spawning peaks in late October and early November, and fry begin emerging from early February through early April (Stillwater Sciences 2009a), although timing may vary somewhat depending on temperatures in different years and tributaries. Table 3.3-3 provides a generalized life history periodicity for fall-run Chinook salmon life stages, with additional timing provided in Appendix E.3.1.1.

Table 3.3-3. Life-history Timing of Fall-run Chinook Salmon in the Klamath River Basin Downstream of Iron Gate Dam. Peak activity is indicated in black.

Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
All Types																								
Incubation	X	X	X	X																X	X	X	X	X
Emergence	X	X	X	X																				
Adult migration														X	X	X	■	X	X	X				
Spawning																				■	X	X		
Type I																								
Rearing	X	X	X	X	X	X	X	X	X	X	X													
Juvenile outmigration			X	X	X	X	X	X	X	X	X	X	X	X										
Type II																								
Rearing					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Juvenile outmigration																	X	X	X	X	X	X		
Type III																								
Rearing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Juvenile outmigration			X	X	X	X	X																	

Fall-run Chinook salmon in the Klamath Basin exhibit three juvenile life-history types: Type I (ocean entry at age 0[80] in early spring within a few months of emergence), Type II (ocean entry at age 0 in fall or early winter), and Type III (ocean entry at age 1 in spring) (Sullivan 1989) (Table 3.3-3). Based on outmigrant trapping at Big Bar on the Klamath River from 1997 to 2000, 63 percent of natural Chinook salmon outmigrants are Type I, 37 percent are Type II, and less than 1 percent are Type III (Scheiff et al. 2001). Although trapping efforts are not equal among seasons, the results are consistent with scale analysis of adult returns by Sullivan (1989).

Critical stressors on fall-run Chinook salmon in the basin include water quality and quantity in the mainstem and within spawning tributaries. Downstream from Iron Gate Dam, the mainstem Klamath River undergoes seasonal changes in flows, water temperature, dissolved oxygen, and nutrients, as well occasional blooms of *Microcystis aeruginosa* (a blue-green algae species that is potentially toxic to fish, as discussed in detail below and in Section 3.4 *Phytoplankton and Periphyton*). During outmigration, juvenile Chinook salmon are vulnerable to contracting disease from pathogens, including the bacterium *Flavobacterium columnare*, and myxozoan parasites *Parvicapsula minibicornis* and *Ceratomyxa shasta*.

Spring-Run Chinook Salmon

Spring-run Chinook salmon in the Klamath Basin are distributed mostly in the Salmon and Trinity rivers and in the mainstem Klamath River downstream from these tributaries during migratory periods, although a few fish are occasionally observed in other areas

[80] A fish emerging in spring is designated as age 0 until January 1st of the following year, when it is designated as age 1 until January 1st of the next year, when it is designated age 2.

(Stillwater Sciences 2009a). Based on data from 2005 to 2014 (CDFW 2015b), the Salmon River contributions to the overall escapement of spring-run Chinook salmon ranged from 1 to 12 percent of the total escapement, and from 1 to 20 percent of the natural escapement. To date, no spring-run Chinook salmon spawning has been observed in the mainstem Klamath River (Shaw et al. 1997). As described above, the BRT (Williams et al. 2011) concluded that while current abundance is low compared with historical abundance (Table 3.3-2), the Chinook salmon population (which includes hatchery fish) appears to have been fairly stable for the past 30 years. However, the BRT noted, as did Myers et al. (1998), that the recent spawner abundance levels of two of the three spring-run population components (Salmon River and South Fork Trinity River) are very low compared to historical abundance (less than 2,000 fish and 1,000 fish, respectively). The BRT was concerned about the relatively few populations of spring-run Chinook salmon and the low numbers of spawners within those populations (Williams et al. 2011).

The BRT (Williams et al. 2011) found the decline in spring-run salmon especially troubling given that historically the spring-run population may have been equal to, if not larger than the fall-run (Barnhart 1994). Huntington (2006) reasoned that spring-run Chinook salmon likely accounted for the majority of the Upper Klamath Basin's actual salmon production under historical conditions. Spring-run Chinook salmon spawned in the tributaries of the Upper Klamath Basin (Moyle 2002, Hamilton et al. 2005, Hamilton et al. 2016) with large numbers of spring-run Chinook salmon spawning in the basin upstream of Klamath Lake in the Williamson, Sprague, and Wood rivers (Snyder 1931). Large runs of spring-run Chinook salmon also historically returned to the Shasta, Scott, and Salmon rivers (Moyle et al. 1995). The runs in the Upper Klamath Basin are thought to have been in substantial decline by the early 1900s and were eliminated by the completion of Copco No. 1 Dam in 1917 (Snyder 1931). The cause of the decline of the Klamath River spring-run Chinook salmon prior to Copco No. 1 Dam has been attributed to dams, overfishing, irrigation, and largely to commercial hydraulic mining operations (Coots 1962, Snyder 1931). These large-scale mining operations occurred primarily in the late 1800's, and along with overfishing, left spring-run Chinook salmon little chance to recover prior to dam construction in the early 1900's. Dams (e.g., Link River Dam, Iron Gate Dam, Lewiston Dam, etc.) have eliminated access to much of the historical spring-run spawning and rearing habitat and are partly responsible for the extirpation of at least seven spring-run populations from the Klamath-Trinity River system (Myers et al. 1998). For example, the construction of Dwinnell Dam on the Shasta River in 1926 was soon followed by the disappearance of the spring-run Chinook salmon run in that tributary (Moyle et al. 1995).

Wild spring-run Chinook salmon from the Salmon River appear to primarily express a Type II life history, based on scale analyses of adults returning from 1990 to 1994 in the Salmon River (Olson 1996), as well as otolith analyses of Salmon River fry and adults (Sartori 2006). A small number of fish employ the Type III life history, although it does not appear to be nearly as prevalent as the Type II.

Spring-run Chinook salmon upstream migration is observed during two-time periods—spring (April through June) and summer (July through August) (Strange 2008) (Table 3.3-4). Snyder (1931) also describes a run of Chinook salmon occurring in the Klamath River during July and August under historical water quality and temperature conditions. Adults spawn from mid-September to late-October in the Salmon River and from September through early November in the South Fork Trinity River (Stillwater Sciences

2009a). Emergence begins in March and continues until early June (West et al. 1990). Age-0 juveniles rearing in the Salmon River emigrate at various times of the year, with one of the peaks of outmigration occurring in April through May (Olson 1996), which would be considered Type I life history. Based on outmigrant trapping from April to November in 1991 at three locations in the South Fork Salmon River, Olson (1996) reported that the greatest peak in outmigration of age-0 juveniles (69 percent) was in mid-October, which would be considered Type II life history. Sullivan (1989) reported that outmigration of Type II age-0 juveniles can occur as late in the year as early-winter. On the South Fork Trinity River outmigration occurs in late-April and May with a peak in May (Dean 1994, 1995), although it is not possible to differentiate between spring- and fall-run juveniles and so the spring-run may have different run timing. Age-1 juveniles (Type III) have been found to outmigrate from the South Fork Trinity River during the following spring (Dean 1994, 1995). Table 3.3-4 provides a generalized life history periodicity for spring-run Chinook salmon life stages, with additional timing provided in Appendix E.3.1.2.

Table 3.3-4. Life-history Timing of Spring-run Chinook Salmon in the Klamath River Basin Downstream of Iron Gate Dam. Peak Activity is Indicated in Black.

Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
All Types																								
Incubation	▒	▒	▒	▒													▒	▒	▒	▒	▒	▒	▒	▒
Emergence			▒	▒																				
Adult migration in mainstem							▒	▒	▒	▒	▒	▒												
Adult entrance into tributaries									▒	▒	▒	▒	▒	▒	▒	▒								
Spawning																	▒	▒	■	▒				
Type I																								
Rearing					▒	▒	▒	▒	▒	▒														
Juvenile outmigration							■	■	■	■														
Type II																								
Rearing					▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒			
Juvenile outmigration																			■	■	▒			
Type III																								
Rearing	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Juvenile outmigration		▒	▒	▒	▒	▒	▒	▒	▒	▒														

It is unclear how much time outmigrating age-0 juveniles spend in the Klamath River mainstem and estuary before entering the ocean. Sartori (2006) did identify a period of increased growth (an estimated mean of 24 days) just prior to reaching an estuarine environment based on otolith analyses of returning adults to the Salmon River, but this period was never clearly linked to mainstem residence. From March to May, there were fair numbers of age-1 juvenile outmigrants captured in the Klamath River Estuary (Wallace 2004). Approximately half were identified to be hatchery age-1 juvenile fall-run Chinook salmon, and the rest were identified to be of natural origin, based on tag expansions.

Stressors on spring-run Chinook salmon related to water quality and quantity are similar to those for fall-run Chinook salmon in the mainstem Klamath River. Although water quality tends to improve in the mainstem downstream from the confluence with the Salmon River (the upstream-most spawning tributary), degradation of water quality (especially temperature and dissolved oxygen) can create critically stressful conditions for spring-run Chinook salmon adults and juveniles for much of the summer (June through September). Production in the Salmon River is primarily controlled by high water temperatures that reduce adult holding and summer rearing habitat in the mainstem Salmon River, while increased fine sediment input within the watershed reduces spawning and rearing habitat quality in some locations (Elder et al. 2002).

Coho Salmon

Coho salmon within the Klamath Basin are included within the Southern Oregon/Northern California Coast (SONCC) coho salmon ESU, which is listed as federally threatened (NMFS 1997a). SONCC coho salmon designated critical habitat includes the Klamath River downstream of Iron Gate Dam, including the estuary (NMFS 1999b). This ESU includes all naturally spawning populations between Punta Gorda, California and Cape Blanco, Oregon, which encompasses the Trinity and Klamath basins (NMFS 1997a). In addition, coho salmon in the Klamath Basin have been listed by the California Fish and Game Commission as threatened under the California Endangered Species Act (CESA) (CDFG 2002a). The Pacific Fishery Management Council (PFMC) considers potential impacts from fishing when setting retention limits each year. The annual coho salmon exploitation rate (proportion of a population that is caught during a year) averaged approximately 5 percent from 2000 to 2013. California waters were open to coho salmon fishing prior to 1998, but currently, coho salmon fishing in California is restricted to tribal harvest under federal reserved fishing rights in the Klamath River. California's statewide prohibition of coho salmon fishing maintains consistently low impacts from freshwater recreational fisheries on SONCC coho salmon (NMFS 2014).

Coho salmon are native to the Klamath Basin. Williams et al. (2006) described nine historical coho salmon populations within the Klamath Basin: the Upper Klamath River, Shasta River, Scott River, Salmon River, Middle Klamath River, Lower Klamath River, and three population units within the Trinity River watershed (Upper Trinity River, Lower Trinity River, and South Fork Trinity River). Note that the designation of these population units varies from the Area of Analysis study reach designations used in this EIR.

Although coho salmon are native to the Klamath River, documentation of coho salmon in the Klamath River is scarce prior to the early 1900's due, in part, to the apparent difficulty of those providing written records in recognizing that there were different species of salmon inhabiting the rivers of the area (Snyder 1931). Snyder (1931) reported that coho salmon were said to migrate to the headwaters of the Klamath River to spawn, but that most people did not distinguish them from other salmon species. Available data suggests that coho salmon were in both mainstem and tributary reaches of the Klamath River upstream to and including Spencer Creek at RM 232.6 (NRC 2004, as cited in NMFS 2007a, Hamilton et al. 2005). While noting that the evidence of historic presence between Fall and Spencer creeks was not conclusive, the 2006 Administrative Law Judge trial-type hearing under Section 241 of the Energy Policy Act of 2005 (NMFS 2006a) determined that coho salmon were abundant at Fall Creek, and that suitable habitat in the Hydroelectric Reach included Spencer, Fall, Beaver, Deer, Shovel, Scotch and Jenny creeks, as well as the main stem of the Klamath River itself.

The final SONCC Coho Salmon Recovery Plan was published on September 9, 2014 (NMFS 2014). Estimated extinction risk is designated as high for the Lower and Upper Klamath River populations, and moderate for the Middle Klamath River population. Estimated extinction risks of the Shasta, Scott, and Salmon river populations are designated as high, moderate, and high, respectively. Extinction risks for the Lower and Upper Trinity River populations are designated as high and moderate, respectively, while the South Fork Trinity River population is designated as high. Williams et al. (2006) describes population units to support recovery planning for the listed SONCC ESU. Analysis of coho salmon in this EIR considers impacts and benefits for each of the nine population units in the Klamath Basin separately but makes a significance determination for all population units combined within the Klamath Basin to be consistent with the approach to assessing other aquatic species populations.

The 2016 five-year status review of SONCC coho salmon (NMFS 2016a) indicated that the ESU's extinction risk has increased since the last status review in 2011. Drought conditions had persisted in four of the prior five years and were ongoing. These conditions are unprecedented in the time since SONCC coho salmon have been listed and were found likely to have resulted in reduced juvenile survival and stressful rearing conditions in nearly all parts of the ESU's range. Those juveniles that survived the freshwater conditions were also found likely to have faced poor ocean conditions, the results of which would only be apparent after these year classes return as adults.

Coho salmon are currently widely distributed in the Klamath River downstream from Iron Gate Dam (RM 193.1), which blocks the upstream migration of coho salmon to historically available habitat in the upper watershed. To minimize and mitigate for adverse effects to coho salmon, PacifiCorp prepared a Habitat Conservation Plan (HCP) for its interim operations of the Klamath Hydroelectric Project (PacifiCorp 2012). This HCP underlines the conservation strategy and measures that PacifiCorp will undertake to address anticipated effects on SONCC coho salmon and their habitat in the Klamath Basin. Per the HCP, PacifiCorp provides funding for the California Klamath Restoration Fund/Coho Enhancement Fund as an Interim Measure (IM2). Between 2009 and 2014, NMFS and CDFW selected 24 projects to benefit coho salmon (PacifiCorp 2014). These projects have been conducted at the mouths of 72 tributaries as well as in Seiad Creek, Scott River, Denny Ditch, Shasta River, Huseman Ditch, McBravey Creek, Fort Goff Creek Stanshaw Creek and Lower Hoopaw Creek. PacifiCorp has developed a partnership with the National Fish and Wildlife Foundation (NFWF) to administer the fund, and this allows grant recipients to apply for additional funding from other grant programs. A Technical Review Team was formed in 2012 and meets annually to review existing projects funded under the Coho Enhancement Fund and to recommend possible adaptive management changes.

Coho salmon use the mainstem Klamath River for some or all of their life history stages (spawning, rearing and migration). However, the majority of returning adult coho salmon spawn in the tributaries to the mainstem (Magneson and Gough 2006, NMFS 2010a).

Adult coho salmon in the Klamath Basin migrate upstream from September through late December, with migration peaking in October and November (Table 3.3-5). Spawning occurs mainly in November and December, with fry emerging from the gravel in the spring, three to four months after spawning, depending on water temperature (Trihey and Associates 1996, NRC 2004) (Table 3.3.-5). Table 3.3-4 provides a generalized life history periodicity for spring-run Chinook salmon life stages, with additional timing provided in Appendix E.3.1.2.

Table 3.3-5. Life-history Timing of Coho Salmon in the Klamath River Basin Downstream of Iron Gate Dam. Peak Activity is Indicated in Black.

Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Incubation	▒	▒	▒	▒	▒																▒	▒	▒	▒
Emergence				▒	■																			
Rearing	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Juvenile redistribution																			▒	▒	▒	▒		
Juvenile outmigration				▒	▒	▒	■	■	■	■														
Adult migration																		▒	▒	■	■	▒	▒	▒
Spawning	▒	▒																			■	■	■	■

Some fry and age-0 juveniles enter the mainstem in the spring and summer following emergence (Chesney et al. 2009). Large numbers of age-0 juveniles from tributaries in the mid-Klamath River move into the mainstem in the fall (October through November) (Soto et al. 2008, Hillemeier et al. 2009). Juvenile coho salmon have been observed to move into off-channel ponds, non-natal tributaries to the Klamath River, downstream portions of the Lower Klamath River, and the estuary for overwintering (Soto et al. 2008, Hillemeier et al. 2009). Some proportion of juveniles generally remain in their natal tributaries to rear.

Age-1 coho salmon migrate downstream from tributaries into the mainstem Klamath River as smolts from February through mid-June with a peak in April and May, which often coincides with the descending limb of the spring hydrograph (NRC 2004, Chesney and Yokel 2003, Scheiff et al. 2001). Once in the mainstem, smolts appear to move downstream rather quickly; Wallace (2004) reported that numbers of coho salmon smolts in the Klamath River Estuary peaked in May, the same month as peak outmigration from the tributaries.

The major activities identified as responsible for the decline of SONCC coho salmon and degradation of their habitat include logging, road building, grazing, mining, urbanization, stream channelization, dams, wetland loss, beaver trapping, artificial propagation, overfishing, water withdrawals, and unscreened diversions for irrigation (NMFS 1997a). In 2007, NMFS published a Klamath River Coho Salmon Recovery Plan to comply with the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006. This level of recovery planning is not as intensive or thorough as the recovery planning process required under the ESA (which to date had not been completed). The 2007 plan includes the following actions identified as high priority for recovery:

- Restore access for coho salmon to the Upper Klamath Basin by providing passage upstream of existing mainstem dams.
- Fully implement the Trinity River Restoration Program.
- Provide incentives for private landowners and water users to cooperate in (1) restoring access to tributary streams that are important for coho spawning and rearing, and (2) enhancing mainstem and tributary flows to improve instream habitat conditions.

- Continue to improve the protective measures already in place to address forestry practices and road building/maintenance activities that compromise the quality of coho salmon habitat.
- Implement restorative measures identified through fish disease research results to improve the health of Klamath River coho salmon populations.

Many of the actions identified in the 2007 plan have been, or are in the process of being, addressed: the Proposed Project in this EIR would address restoration of access for coho salmon; the Trinity River Restoration Program is currently being implemented; and, many private landowners and water users are restoring coho access and habitat to stream reaches and they are addressing forestry practices that could harm fish. Fish disease issues are being researched and addressed, most recently in 2013 when the NMFS and USFWS issued a joint Biological Opinion (2013 BiOp; NMFS, and USFWS 2013) for the USBR's Klamath Irrigation Project operations, as described in detail in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*. While the 2013 BiOp is for operations upstream of the Lower Klamath Project, the conditions of the 2013 BiOp form an important part of the existing condition for coho salmon downstream of Iron Gate Dam, and, as discussed below, are intended to reduce coho disease rates. In this joint BiOp, NMFS consulted on coho salmon, while USFWS consulted on listed suckers (discussed below under *Lost River and Shortnose Suckers*).

In the 2013 BiOp, NMFS concluded that the effect of proposed USBR Klamath Irrigation Project operations on flows would result in habitat reductions for coho salmon juveniles in the mainstem Klamath River. To offset these negative effects, the 2013 BiOp includes flow release requirements to reduce disease incidence for coho salmon in the Klamath River downstream of Iron Gate Dam. The formulaic approach to flow releases designed to benefit coho salmon, as described in the 2013 BiOp, prioritizes a volume of water set-aside in an Environmental Water Account (EWA) for releases in the spring, and minimum daily flow targets in April through June to meet Hardy et al. (2006) recommended ecological base flows (discussed further in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*). The 2013 BiOp found that Klamath Irrigation Project operations were not likely to diminish habitat for coho salmon fry and juveniles in the Upper Klamath, Middle Klamath, Shasta, and Scott river populations to an extent that would reduce life history diversity.

In their 2013 BiOp analysis of the Klamath Irrigation Project operations, NMFS concluded that the proposed flow releases would result in coho salmon disease risks that are lower than observed period of record conditions, yet higher than under natural flow conditions (NMFS and USFWS 2013). Of all the adverse effects of the proposed Klamath Irrigation Project operations, NMFS concluded that risk of fish disease due to the myxozoan parasite *Ceratomyxa shasta* (*C. shasta*) is the most significant for coho salmon, since *C. shasta* is a key factor limiting salmon recovery in the Klamath River (e.g., Foott et al. 2009). The adaptive management element of the USBR's Klamath Irrigation Project proposed operations was intended to minimize disease risks to coho salmon during average to below average water years if EWA surplus volume is available. Lastly, NMFS concluded that the proposed minimum daily flows below Iron Gate Dam in April to June would limit the increase in disease risks posed to coho salmon from Klamath Irrigation Project operations. The Klamath Irrigation Project directs flow requirements in the Klamath River below Iron Gate Dam by releases from the Lower Klamath Project's Iron Gate Dam consistent with the 2013 BiOp issued on the Klamath

Irrigation Project. By lowering the disease risk, NMFS asserted that coho salmon abundance would likely improve over the next ten years for the Upper Klamath, Middle Klamath, Shasta, and Scott river populations.

However, the first years of 2013 BiOp implementation included severe drought conditions, and although the USBR was operating the Klamath Irrigation Project in accordance with the 2013 BiOp, the infection rate for *C. shasta* in the Klamath River downstream of Iron Gate Dam greatly exceeded the incidental take maximum (U.S. District Court 2017a). As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, this led to a court order requiring USBR to implement three specific flows in the Klamath River, as measured immediately downstream of Iron Gate Dam: annual winter-spring surface flushing flows, biennial winter-spring deep flushing flows, and spring-summer emergency dilution flows (U.S. District Court 2017a–c). The court also required that USBR re-initiate consultation with NMFS and the USFWS regarding the effects of the Klamath Irrigation Project operations on coho salmon in the Klamath River and Lost River and shortnose suckers in the Upper Klamath Basin (U.S. District Court 2017a–c). The court-ordered flushing flows and emergency dilution flows are not part of existing conditions for the Proposed Project, because they went into effect after the Notice of Preparation was filed by the State Water Board in December 2016, and because the data evaluating the effectiveness of the flows and their potential impacts is not yet robust. The flushing and emergency dilution flows are detailed in Section 4.2.1.1 *[Alternative Description] Summary of Available Hydrology Information for the No Project Alternative* as part of the No Project Alternative because they would likely only apply if Iron Gate Dam were to remain in place or the disease nidus remains. These flows are also discussed in Section 4.4 *Continued Operations with Fish Passage Alternative*.

Steelhead

Steelhead are highly adaptive salmonids, with multiple life histories (Hodge et al. 2016). Klamath Basin summer steelhead and winter steelhead populations both belong to the Klamath Mountain Province ESU, which is not listed under the ESA. The NMFS (2001) status review found that this ESU was not in danger of extinction or likely to become so in the foreseeable future, based on estimated populations for the ESU and lower estimates of genetic risk from naturally spawning hatchery fish than estimated in previous reviews, and consideration of existing conservation efforts that are benefiting steelhead in the ESU.

Summer Steelhead

The Klamath Mountain Province ESU of summer steelhead is a CDFW Species of Special Concern and is distributed throughout the Klamath River downstream from Iron Gate Dam and in its tributaries. This species historically used habitat upstream of Upper Klamath Lake prior to the construction of Copco No. 1 Dam (Hamilton et al. 2005). However, some populations such as the Salmon River summer steelhead have declined significantly in the past several decades (Quiñones et al. 2013), and in general summer steelhead populations in the ESU are currently in low abundance (Moyle et al. 2017). Based on available escapement data from summer direct observation surveys, approximately 55 percent of summer steelhead spawn in the Trinity River and other lower-elevation tributaries (CDFW and USDA Forest Service 2002, unpubl. data). Most remaining summer steelhead are believed to spawn in tributaries between the Trinity River (RM 43.3) and Seiad Creek (RM 132.7), with high water temperatures limiting their use of tributaries to the Klamath River farther upstream (NRC 2004). Adult summer steelhead use the mainstem Klamath River primarily as a migration corridor to access holding and spawning habitat in tributaries.

Summer steelhead adults enter and migrate up the Klamath River from March through June while sexually immature (Hopelain 1998), then hold in cooler tributary habitat until spawning begins in December (USFWS 1998) (Table 3.3-6). Forty to 64 percent of summer steelhead in the Klamath River exhibit repeat spawning, with adults observed to migrate downstream to the ocean after spawning (also known as "runbacks") (Hopelain 1998). Summer steelhead in the basin also have a "half-pounder" life-history pattern, in which an immature fish emigrates to the ocean in the spring, returns to the river in the fall, spends the winter in the river, then emigrates to the ocean again the following spring (Busby et al. 1994, Moyle 2002). Table 3.3-6 provides a generalized life history periodicity for summer steelhead life stages, with additional timing provided in Appendix E.3.1.4.

Table 3.3-6. Life-history Timing of Summer Steelhead in the Klamath River Basin Downstream of Iron Gate Dam. Peak Life-history Periods are Shown in Black.

Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Incubation	░	░	░	░	░	░	░	░	░	░	░	░											░	░
Emergence						░	░	░	░	░	░	░												
Rearing	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░
Juvenile outmigration					░	░	░	░	░	░														
Half-pounder residence	░	░	░	░	░	░										░	░	░	░	░	░	░	░	░
Adult migration in mainstem					░	░	░	░	░	░	░	░												
Adult holding in tributaries													░	░	░	░	░	░	░	░	░	░	░	
Spawning	░	░	░	░																			░	░
Run-backs							░	█	░	░														

Juvenile summer steelhead in the Klamath Basin may rear in freshwater for up to three years before outmigrating. Although many juveniles migrate downstream at age-1 (Scheiff et al. 2001), those that outmigrate to the ocean at age 2 appear to have the highest survival (Hopelain 1998). Juveniles outmigrating from tributaries at age-0 and age-1 may rear in the mainstem or in non-natal[81] tributaries (particularly during periods of poor water quality) for one or more years before reaching an appropriate size for smolting. Age-0 juvenile steelhead have been observed migrating upstream into tributaries, off-channel ponds, and other winter refuge habitat in the Lower Klamath River (Stillwater Sciences 2010). Juvenile outmigration occurs primarily during spring. Smolts are captured in the mainstem and estuary throughout the fall and winter (Wallace 2004), but peak smolt outmigration normally occurs from April through June, based on estuary captures (Wallace 2004). Temperatures in the mainstem are generally suitable for juvenile steelhead, except during periods of the summer, especially upstream of Seiad Valley (for more species information see USFWS 1998, Moyle 2002, NRC 2004, and Stillwater Sciences 2009a). Critical limiting factors for summer steelhead include degraded habitats, passage impediments, predation, and competition (Moyle et al. 2008).

Winter Steelhead

[81] Tributary other than the one in which it was born.

Moyle (2002) describes steelhead in the Klamath Basin as having a summer- and winter-run. Some divide the winter-run into fall and winter-runs (Barnhart 1994, Hopelain 1998, USFWS 1998, Papa et al. 2007). In this section, "winter steelhead" refers to both fall- and winter-runs except in cases when the distinction is pertinent to the discussion, and wherever data was sufficient to analyze them separately.

Winter steelhead are widely distributed throughout the Klamath River and its tributaries downstream from Iron Gate Dam, and historically used habitat upstream of Upper Klamath Lake (Hamilton et al. 2005). Butler et al. (2010) found that 93 percent of the 41 *Oncorhynchus mykiss* specimens excavated from archeological sites above Upper Klamath Lake were anadromous (indicating occurrence of steelhead historically upstream of Upper Klamath Lake). Winter steelhead adults generally enter the Klamath River from July through October (fall-run) and from November through March (winter-run) (USFWS 1998, Stillwater Sciences 2010). They spawn mainly in tributaries throughout the Klamath River Basin downstream of Iron Gate Dam, and occasionally within the mainstem (NRC 2004). Winter steelhead migrate upstream primarily from January through April (USFWS 1998), with peak spawn timing in February and March (ranging from January to April) (NRC 2004) (Table 3.3-7). Adults may repeat spawning in subsequent years after returning to the ocean in the spring following spawning. Immature "half-pounders" return after a short (<1 year) ocean residence each year in September through March and typically use the mainstem Klamath River to feed until returning to the ocean (NRC 2004), although they also use larger tributaries such as the Trinity River (Dean 1994, 1995). Table 3.3-7 provides a generalized life history periodicity for spring-run Chinook salmon life stages, with additional timing provided in Appendix E.3.1.4.

Table 3.3-7. Life-history Timing of Fall-and Winter-run Steelhead and Rainbow Trout in the Klamath River Basin Downstream of Iron Gate Dam. Peak Life-history Periods are Shown in Black.

Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Incubation	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒												
Emergence						▒	▒	▒	▒	▒	▒	▒												
Rearing	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Juvenile outmigration					▒	▒	▒	▒																
Half-pounder residence	▒	▒	▒	▒	▒	▒										▒	▒	▒	▒	▒	▒	▒	▒	▒
Fall-run adult migration													▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Winter-run adult migration	▒	▒	▒	▒	▒	▒															▒	▒	▒	▒
Spawning	▒	▒	■	■	■	■	▒	▒	▒															
Run-backs							▒	▒	▒	▒														

Fry emerge in spring (NRC 2004), with fry observed in outmigrant traps in Bogus Creek and Shasta River from March through mid-June (Dean 1994). Age-0 and age-1 juveniles have been captured in outmigrant traps in spring and summer in tributaries to the Klamath River upstream of Seiad Creek (CDFG 1990a, b). These fish are likely rearing in the mainstem or non-natal tributaries before outmigrating to the ocean as age-2 outmigrants.

Juvenile outmigration appears to primarily occur between May and September with peaks between April and June, although smolts are captured in the estuary as early as

March and as late as October (Wallace 2004). Most adult returns originate from fish that smolt at age-2, representing 86 percent of adult returns; in comparison with only 10 percent for age-1 juveniles and 4 percent for age 3+ juveniles (Hopelain 1998).

Similar limiting factors listed for summer steelhead also affect winter steelhead populations, including degraded habitats, decreased habitat access, fish passage, predation, and competition (for more species information see USFWS 1998, NRC 2004, Wallace 2004, and Stillwater Sciences 2009a).

Coastal Cutthroat Trout

Klamath River coastal cutthroat trout belong to the Southern Oregon/California Coasts ESU. Coastal cutthroat trout within the Area of Analysis for aquatic resources is listed as a CDFW Species of Special Concern and a USDA Forest Service Sensitive Species. In a 1999 status review, NMFS determined that the Southern Oregon/California Coasts ESU did not warrant ESA listing (Johnson et al. 1999). Coastal cutthroat trout are distributed primarily within smaller tributaries to the 22 miles of the Klamath River mainstem upstream of the estuary (NRC 2004), but also within tributaries to the Trinity River (Moyle et al. 1995).

Coastal cutthroat trout have not been extensively studied in the Klamath Basin, but it has been noted that their life history is similar to fall- and winter-run steelhead in the Klamath River (NRC 2004). Both resident and anadromous life histories are observed in coastal cutthroat trout in the Klamath Basin. Anadromous adults enter the river to spawn in the fall. Moyle (2002) noted that upstream migration in northern California spawning streams tends to occur from August to October after the first substantial rain. Generally, spawning of anadromous and resident coastal cutthroat trout may occur from September to April (Moyle 2002). “Sea-run” adults spend some time in the ocean without fully adopting a fixed anadromous life history may either return to rivers in summer to feed or return in September or October to spawn and/or possibly overwinter (NRC 2004). Cutthroat with a resident life history remain in freshwater for their entire lives and may use mainstem and/or tributary habitats.

Juvenile coastal cutthroat trout may spend anywhere from one to three years in freshwater to rear. Anadromous or sea-run juveniles outmigrate during April through June, at the same time as Chinook salmon juvenile downstream migration (Moyle 2002, NRC 2004). These juveniles also appear to spend at least some time rearing in the estuary. Wallace (2004) found that estuary residence time ranged from 5 to 89 days, with a mean of 27 days, based on a mark-recapture study.

Pacific Lamprey

Pacific lamprey are the only anadromous lamprey species in the Klamath Basin. Pacific lamprey, along with three other lamprey species found in California, Oregon, Washington and Idaho, were petitioned for ESA listing in 2003 (Nawa 2003). Although the USFWS halted species status review in December 2004 due to inadequate information (USFWS 2004), efforts to resume the review Pacific lamprey are anticipated as more information is obtained. Although no historical abundance data are available, recent estimates are that there are annual runs of over 4,000 Pacific lamprey in the Klamath Basin (Goodman and Reid 2012, Table 3.3-2).

Pacific lamprey are found in Pacific Ocean coast streams from Alaska to Baja California. They occur throughout the mainstem Klamath River downstream from Iron Gate Dam and its major tributaries including: Trinity, Salmon, Shasta, and Scott River basins (Stillwater Sciences 2009a). Although the evidence is inconclusive as to whether Pacific lamprey were historically present upstream of Iron Gate Dam, the record of evidence shows that access to habitat would benefit Pacific lamprey by providing additional spawning and rearing grounds (NMFS 2006a). Pacific lamprey are capable of migrating long distances and show similar distributions to anadromous salmon and steelhead (Hamilton et al. 2005).

Pacific lamprey are anadromous nest builders that die shortly after spawning. They enter the Klamath River on their own volition during all months of the year, with peak upstream migration occurring from December through June (Stillwater Sciences 2009a) (Table 3.3-8, life history timing detailed in Appendix E.3.1.5). As adults, Pacific lamprey do not feed in freshwater. Spawning occurs at the upstream edge of riffles in sandy gravel from mid-March through mid-June (Stillwater Sciences 2009a). After lamprey eggs hatch, the larvae (ammocoetes) drift downstream to backwater areas and burrow into the substrate, feeding on algae and detritus (FERC 2007). Based on observations and available habitat, most ammocoete rearing likely occurs in the Salmon, Scott, and Trinity rivers, as well as throughout the mainstem Klamath River from Iron Gate downstream to the estuary (FERC 2007). The Klamath River upstream of the Shasta River appears to have less available spawning and rearing habitat, and Pacific lamprey are not regularly observed there (FERC 2007). Juveniles remain in freshwater for five to seven years (with slower growing individuals leaving at older ages) before they migrate to the ocean and transform into adults (Moyle 2002). Pacific lamprey spend one to three years in the marine environment (with no documented cause of variability in marine residency), where they parasitize a wide variety of ocean fishes, including Pacific salmon, flatfish, rockfish, and pollock (Close et al. 2010). For more species information see Close et al. (2010), Stillwater Sciences (2009a), and PacifiCorp (2004a).

Table 3.3-8. Life-history Timing of Pacific Lamprey in the Klamath River Basin Downstream of Iron Gate Dam. Peak Activity is Indicated in Black.

Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Incubation																								
Rearing																								
Juvenile outmigration																								
Adult migration																								
Spawning																								

Major factors believed to be affecting their populations include barriers to upstream migration at dams, dewatering of larval habitat through flow regulation, stranding due to rapid downramping, reduced larval habitat by increasing water velocity and/or reducing sediment deposition areas when sediment is trapped at dams, and mortality due to exposure to contaminants in the larval stage (Close et al. 2002, as cited in Hamilton et al. 2011).

<u>Green Sturgeon</u>

Green sturgeon are an anadromous species that occurs in coastal marine waters from Mexico to the Bering Sea. NMFS has identified two DPSs: (1) the Northern Green Sturgeon DPS, which is not listed as threatened or endangered but is on NMFS' Species of Concern list and which includes populations spawning in coastal watersheds from the

Eel River north, and (2) the Southern Green Sturgeon DPS, listed as threatened under the federal ESA and encompassing coastal or Central Valley populations spawning in watersheds south of the Eel River (NMFS 2006b). Although the Southern Green Sturgeon DPS is considered a separate population from the Northern Green Sturgeon DPS based on genetic data and spawning locations, their ranges outside of the spawning season tend to overlap (CDFG 2002b, Israel et al. 2004, Moser and Lindley 2007). The Klamath Basin may support most of the spawning population of Northern Green Sturgeon DPS (Adams et al. 2002). Although Southern Green Sturgeon DPS may enter other west coast estuaries to feed in the summer and fall, there has been no documentation of them entering the Klamath River or its estuary (USBR 2010). No Northern Green Sturgeon DPS tagged by the Yurok Tribe within the Klamath River have ever been detected in the range of Southern Green Sturgeon DPS (primarily San Francisco Bay) despite the presence of numerous receivers that would have detected tagged Klamath River fish if they had ventured there (McCovey 2011a). No Southern Green Sturgeon DPS tagged in the Sacramento/San Joaquin and/or San Francisco Bay region have ever been detected in the Klamath River. Southern Green Sturgeon DPS have been detected immediately offshore of the Klamath River, but have not been detected in the Klamath River Estuary or mainstem despite the presence of functioning acoustic receivers in the Klamath River Estuary (McCovey 2011a). Based on the available evidence it appears unlikely that sturgeon from the Southern Green Sturgeon DPS currently occur within the Klamath River or nearshore environment. Therefore, the rest of this section pertains only to the Northern Green Sturgeon DPS.

Northern Green Sturgeon DPS in the Klamath River sampled during their spawning migration ranged in age from 16 to 40 years (Van Eenennaam et al. 2006). It is believed that in general green sturgeon have a life span of at least 50 years, and spawn every four years on average after around age-16, for approximately eight spawning efforts in a lifetime (Klimley et al 2007). Green sturgeon enter the Klamath River to spawn from March through July (Table 3.3-9). Green sturgeon spawn primarily in the lower 67 miles of the mainstem Klamath River (downstream from Ishi Pishi Falls, directly upstream of the confluence with the Salmon River), in the Trinity River, and occasionally in the lower Salmon River (KRBFTF 1991, Adams et al. 2002, Benson et al. 2007). Most green sturgeon spawning occurs from the middle of April to the middle of June (NRC 2004). After spawning, approximately 25 percent of green sturgeon migrate directly back to the ocean (Benson et al. 2007), and the remainder hold in mainstem pools in the Klamath River between RM 13 and RM 66.3 through November prior to migrating downstream to the ocean. Table 3.3-9 illustrates the periodicity of green sturgeon in the Klamath River. Additional timing detail is provided in Appendix E.3.1.6.

Table 3.3-9. Life-history Timing of Green Sturgeon in the Klamath River Basin Downstream of Iron Gate Dam. Peak Activity is Indicated in Black.

Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Incubation/emergence												
Rearing												
Juvenile outmigration												
Adult migration												
Spawning												
Post-spawning adult holding												

During the onset of fall rainstorms and increased river flow, adult sturgeon move downstream and leave the river system (Benson et al. 2007). Juvenile green sturgeon may rear for one to three years in the Klamath River Basin before they migrate to the estuary and ocean (NRC 2004, FERC 2007, CALFED 2007), usually during summer and fall (Emmett et al. 1991, as cited in CALFED 2007, CH2M Hill 1985, Hardy and Addley 2001).

Adult green sturgeon that have held over the summer in the Klamath River after spawning appear to migrate downstream to the ocean in conjunction with increases in discharge in the fall. Attenuation of high flows downstream from Iron Gate Dam as a result of USBR Klamath Irrigation Project operations may affect a key environmental cue used to stimulate the fall outmigration of adult green sturgeon that have remained in holding pools over the summer (Benson et al. 2007). Historically Klamath River below Iron Gate Dam was relatively responsive to discharge increases related to rainfall events, and the timing of peak flows changed significantly following implementation of USBR Klamath Irrigation Project operations on the Klamath River (Balance Hydrologics, Inc. 1996). When compared to pre- Klamath Irrigation Project operations, existing flows in October are higher and flows in late spring and summer are lower (Balance Hydrologics, Inc. 1996).

Resident Riverine Fish Species

<u>Rainbow and Redband Trout</u>

Rainbow trout exhibit a wide range of life-history strategies, including anadromous forms (steelhead, described above) and resident forms, described here. The Klamath Basin has two subspecies of rainbow trout. Behnke (1992) identifies the inland form as the Upper Klamath redband trout, *Oncorhynchus mykiss newberrii*, but considers steelhead and resident rainbow trout downstream from Upper Klamath Lake to be primarily coastal rainbow trout, *Oncorhynchus mykiss irideus*. Since construction of Copco No. 1 Dam and Iron Gate Dam, resident trout upstream of Iron Gate Dam are considered redband trout, and resident trout downstream from Iron Gate Dam are considered coastal rainbow trout (FERC 2007). Coastal rainbow trout are widely distributed downstream of Iron Gate Dam, including occasionally within the mainstem Klamath River, and predominately within every major tributary and most smaller tributaries with perennial flow as well. Their habitat requirements, sensitivities to disease and water quality are the same as those described above for steelhead. Rainbow trout are distinguished from steelhead by a life history that is limited to freshwater. Juveniles rear in mainstem and tributary habitat from two to three years before reaching sexual maturity (with faster growing individuals maturing sooner), and adults spawn in tributaries.

Behnke (2002) indicates that two distinct groups of redband trout may be in the Upper Klamath Basin: one that is adapted to lakes and another that is adapted to streams. These fish are a popular recreational fishery. The Upper Klamath Basin supports the largest and most functional adfluvial[82] redband trout population of Oregon's interior basins (Hamilton et al. 2011). In the Hydroelectric Reach, most redband trout spawning is thought to occur in Spencer and Shovel creeks. Redband trout need to migrate among habitats, mainstem, tributaries, and reservoirs to meet their life-history requirements. Redband trout are considered resistant to *C. shasta* or other diseases potentially brought upstream by anadromous fishes (Hamilton et al. 2011).

For more information on rainbow and redband trout, see USFWS (1998); USFWS (2000); Behnke (2002); Moyle (2002); NRC (2004); PacifiCorp (2004a); Starcevich et al. (2006); and Messmer and Smith (2007).

Resident Lampreys

In addition to the anadromous Pacific lamprey, described above, at least three resident species are present in the California portion of the Klamath Basin (PacifiCorp 2006, Hamilton et al. 2011):

- Northern California brook lamprey (*Entosphenus folletti*);
- Western brook lamprey (*Lampetra richardsoni*); and
- Klamath River lamprey (*Lampetra similis*).

No lamprey species are listed as threatened or endangered on either the California or Federal ESA lists (CDFW 2018a). However, all three resident species are listed in California as Species of Special Concern (Moyle et al. 2015). All resident lamprey species have a similar early life history where ammocoetes drift downstream to areas of low velocity with silt or sand substrate and proceed to burrow into the stream bottom and live as filter feeders for two to seven years (USFWS 2004). After they transform into adults, the non-parasitic species (Northern California brook lamprey, western brook lamprey) do not feed, while the parasitic Klamath River lamprey feed on a variety of fish species (FERC 2007).

Klamath River lamprey are found both upstream and downstream from Iron Gate Dam, from Spencer Creek downstream, and are common in the Lower Klamath River and the low-gradient tributaries there (NRC 2004). They are also found in the Trinity River, and in the Link River of the Upper Klamath Basin (Lorion et al. 2000, as cited in Close et al. 2010).

In the Klamath River Basin, Western brook lamprey are known to occur only in Hunter and McGarvey creeks, near the mouth of the Klamath River (Close et al. 2010). Early studies of Western brook lamprey were conducted outside of California (Moyle et al. 2015), and therefore there is no information on the life history, distribution, or abundance of this species in the Klamath River Basin prior to the construction of the Lower Klamath Project. Because they are known to occur only in streams near the mouth of the Klamath River, the effects from the existing dams would be confined to flow alteration in the mainstem, to the extent that Western brook lamprey use the mainstem for dispersal or other life history events.

[82] Life history strategy in which adult fish spawn and juveniles subsequently rear in streams but migrate to lakes for feeding as subadults and adults.

Northern California brook lamprey (also known as the Modoc brook lamprey) are found upstream of Iron Gate Dam (Close et al. 2010). They have been reported from a tributary to the Lost River in the Clear Lake Basin and are potentially also found in Fall Creek (Close et al. 2010). Moyle et al. (2015) report that Northern California brook lamprey are known to occur in Willow and Boles creeks above Clear Lake Reservoir. Northern California brook lamprey was not described as a separate species until 1976 (based on museum specimens) and was not recognized as a species by the American Fisheries Society until 2013 (Moyle et al. 2015). Therefore, there is no information on the life history, distribution, or abundance of this species prior to the construction of the Lower Klamath Project. Moyle et al. (2015) states that the only known populations are above large reservoirs, which suggests that they are isolated from other populations. Moyle et al. (2015) reports that dams and diversions on the upper Klamath River and Lost River alter downstream flows and habitats, potentially negatively affecting the downstream populations.

Cyprinids

The native blue chub (*Gila coerulea)* and tui chub (*Gila bicolor*) are both found in the Klamath Basin, including Lost River, Lower Klamath Lake, Tule Lake, and Iron Gate and Copco No. 1 reservoirs (CH2M Hill 2003). These species prefer habitat with quiet water, well-developed beds of aquatic plants, and fine sediment or sand bottoms. Although blue and tui chubs can withstand a variety of conditions including cold, clear lake water, and can also tolerate low dissolved oxygen levels, they are most often found in habitats with summer water temperatures higher than 68°F. These fish are omnivores, they feed on sediment detritus, and can play an important role in nutrient cycling through the excretion of nutrients into the water column in forms available to primary producers (e.g., phytoplankton). Both species of chub found in the Klamath Basin spawn from April through July, in shallow rocky areas in temperatures of 59 to 64.4°F (Moyle 2002). Presumably dams and diversions have benefitted both of these species by increasing the availability of its preferred warmer, low-velocity habitat.

Sculpin

Several sculpin species are found in coastal streams and rivers from Alaska to southern California. Several species of sculpin are known to occur in the California portion of Klamath River and its estuary, including Pacific staghorn (*Leptocottus armatus*), prickly (*Cottus asper*), slender (*Cottus tenuis*), sharpnose (*Clinocottus acuticeps*), coastrange (*Cottus aleuticus*), and marbled (*Cottus klamathensis*). Of these, only the marbled and slender sculpins are known to occur upstream of Iron Gate Dam (Carter and Kirk 2008). Mainstem Klamath River habitat may be important to sculpin populations as it can provide an important migration corridor from the estuary to upstream riverine reaches (White and Harvey 1999). Pacific staghorn sculpin are found predominantly in brackish waters of the estuary. Coastal populations of prickly and coastrange sculpin are generally assumed to be dependent on the estuary for part of their early life history (White and Harvey 1999). The marbled sculpin is a relatively wide-ranging species found in a variety of habitats in northern California and southern Oregon (Daniels and Moyle 1984). Marbled sculpin are found mainly in low gradient, spring-fed streams and rivers where the water temperature is less than 68°F in the summer and in habitat with fine substrate that can support beds of aquatic plants. They are typically found in 60 to 70 centimeters of water and in velocities around 23 centimeters per second (approximately 0.36 gallons per minute) (Moyle 2002). Slender sculpin were likely historically common in the Williamson, Sprague, Sycan, and Lost rivers and in Upper

Klamath Lake (Bentivoglio 1998, cited in NRC 2004). Bentivoglio (1998) collected sculpins throughout the upper basin in 1995–1996 and found slender sculpins only in the lower Williamson River and a few in Upper Klamath Lake. Little is known about the species' biological requirements (NRC 2004). Sharpnose sculpin are primarily found in marine and brackish conditions, although they can tolerate freshwater (Love 2011). As such, they are likely restricted to the Klamath River Estuary and possibly the lower mainstem Klamath River.

Lost River and Shortnose Suckers

The Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*) are endemic to the Upper Klamath Basin of southern Oregon and northern California (Moyle 2002). These species share similar distribution and habitat requirements, and thus are typically managed together. The Lost River sucker and the shortnose sucker are listed as endangered under the ESA (USFWS 1988) and are endangered under CESA. A Revised Recovery Plan for the Lost River sucker and Shortnose sucker (revised recovery plan) was published in 2013 (USFWS 2013a). The final designation of critical habitat for both species was published by the USFWS on December 11, 2012 (USFWS 2012). Both species are also fully protected species under California Fish and Game Code Section 5515(a)(3)(b)(4) and (6), respectively. Under Fish and Game Code section 2081.11, take of the Lost River and shortnose suckers may be authorized for Klamath River dam removal, so long as the take will not result in jeopardy for the species, is minimized, and mitigation incorporates information from sampling efforts.

The 2013 revised recovery plan (USFWS 2013a) identifies a recovery unit for both of these species within the California portion of the Area of Analysis: the reservoirs along the Klamath River downstream of Keno Dam (including Iron Gate and Copco reservoirs), known as the Klamath River Management Unit. Populations in the Klamath River Management Unit are comprised mostly of adults (USFWS 2013a). The USFWS (2013a) recovery plan considers these populations as "sink populations", as they are not likely self-sustaining because of low recruitment due to the lack of access to spawning habitats, citing Moyle (2002), and NRC (2004). Extensive sampling was conducted by Oregon State University (Desjardins and Markle 1999) in J.C. Boyle, Copco No. 1 and Iron Gate reservoirs during 1998 and 1999 using multiple gear types (trammel nets, beach seines, cast nets, trap nets, backpack electrofishing, and otter trawls). Sampling gears, seasons and locations were selected to maximize the collection of suckers and different sucker life stages, and thus the results may not be representative of the larger fish community. Adult suckers were sampled for in 1997, 1998 and 1999 (with trammel nets), while larval and juvenile suckers were only sampled in 1998 and 1999. Over three years of study, a total of 50 shortnose sucker adults were collected in J.C. Boyle Reservoir, 165 in Copco No. 1 Reservoir and 22 in Iron Gate Reservoir. Lost River suckers were present in J.C. Boyle Reservoir and Copco No. 1 Reservoir, but at much lower numbers, with just one collected in Copco No.1 Reservoir and two in J.C. Boyle Reservoir. Larval suckers (species unknown) were more abundant with 275 collected over two years in J.C. Boyle Reservoir, 8,729 in Copco No. 1 Reservoir, and 1,177 in Iron Gate Reservoir. A total of 23 juveniles were collected in J.C. Boyle Reservoir and 3 in Copco No.1 Reservoir. In all, shortnose sucker represented 1 percent (1998) and 2 percent (1999) of the trammel net catch in J.C. Boyle Reservoir, 12 percent (1998) and 14 percent (1999) in Copco No.1 Reservoir and 0.3 percent (1998) and 2 percent (1999) in Iron Gate Reservoir. Juveniles were only a significant portion of the seine net catch in J.C Boyle Reservoir, representing 17 percent of the catch in 1998 and 9 percent in 1999. In larval trawls, sucker larvae represented only 0.2 to 5 percent of the catch in all reservoirs in 1998, but those percentages increase to 27 percent (J.C. Boyle Reservoir), 44 percent (Copco No.1 Reservoir) and 30 percent (Iron Gate Reservoir) in 1999.

To minimize and mitigate for adverse effects to both sucker species, PacifiCorp prepared an HCP for its interim operations of the Klamath Hydroelectric Project (i.e., prior to dam removal) (PacifiCorp 2013). This HCP includes the conservation strategy and measures that PacifiCorp would undertake to address anticipated effects on suckers and their habitat in the Klamath Basin. The conservation measures outlined follow a two-pronged approach: (1) manage the shutdown of East- and West-side powerhouses (which are part of the Klamath Hydroelectric Project in Oregon, see Figure 3.3-1) in such a way as to minimize effects on listed suckers, resulting in additional benefits by reducing possible entrainment, ramping events, and false attraction to powerhouse tailraces; and (2) improve habitat conditions for listed suckers by facilitating/funding specific enhancement projects, a sucker conservation fund, and the Nature Conservancy's (TNC) Williamson River Delta Restoration Project.

In the 2013 BiOp (NMFS and USFWS 2013), USFWS consulted on both sucker species. USFWS concluded that the proposed USBR Klamath Irrigation Project operations affects both Lost River and shortnose suckers. In the Klamath River Management Unit, USFWS concluded that effects of the proposed operations on both species are likely small in comparison to other effects because there are fewer suckers present in the reservoirs, so effects are primarily limited to changes in water quality (USFWS 2007).

Existing threats to the sucker populations include: the damming of rivers, instream flow diversions, hybridization (e.g., between shortnose sucker and Klamath largescale suckers [*Catostomus snyderi*]), competition and predation by exotic species, dredging and draining of marshes, water quality problems associated with timber harvest, the removal of riparian vegetation, livestock grazing, agricultural practices, and low lake elevations, particularly in drought years (USFWS 1993). Reduction and degradation of lake and stream habitats in the Upper Klamath Basin is considered by USFWS to be the most important factor in the decline of both species (USFWS 1993).

Miller and Smith (1981) claimed that sucker hybridization was most pronounced in the Lower Klamath Project reservoirs, and Markle et al. (2005) reported hybridization between small scale sucker and both Lost River and shortnose suckers in the Hydroelectric Reach. Hybridization prompted Buettner et al. (2006) and others to caution against supporting migration of individuals from Iron Gate and Copco reservoirs into the Upper Klamath Lake population.

The Lost River sucker historically occurred in Upper Klamath Lake (Williams et al. 1985) and its tributaries and the Lost River watershed, Tule Lake, Lower Klamath Lake, and Sheepy Lake (Moyle 1976). Shortnose suckers historically occurred throughout Upper Klamath Lake and its tributaries (Williams et al. 1985, Miller and Smith 1981). The present distribution of both species includes Upper Klamath Lake and its tributaries (Buettner and Scoppettone 1990), Clear Lake Reservoir and its tributaries (USFWS 1993), Tule Lake and Lost River up to Anderson-Rose Dam (USFWS 1993), and the Klamath River downstream of Iron Gate Reservoir (USFWS 1993). Shortnose suckers occur in Gerber Reservoir and its tributaries, but Lost River suckers do not.

Lost River and shortnose suckers are lake-dwelling, but spawn in tributary streams or springs (USFWS 1988). They spawn from February through May, depending on water depth and stream temperature (Buettner and Scoppettone 1990, Andreasen 1975, USFWS 2008). Spawning locations appear to be both substrate and flow dependent (although specific preferred flow velocities are unknown), with an apparent preference for gravel substrates (where eggs incubate in the interstices). When spawning occurs over cobble and armored substrate, eggs fall between crevices or are swept downstream and lost (Buettner and Scoppettone 1990). Larval Lost River and shortnose suckers spend relatively little time in tributary streams, migrating to lake habitat shortly after emergence, typically in May and early June (Buettner and Scoppettone 1990). Adults return to Upper Klamath Lake soon after spawning. Lake fringe emergent vegetation is the primary habitat used by larval suckers (Cooperman and Markle 2004). Juvenile suckers use a wide variety of habitat including near-shore areas with or without emergent vegetation and off-shore habitat (Hamilton et al. 2011).

Smallscale Sucker

The Klamath smallscale sucker (*Catostomus rimiculus*) is common and widely distributed in the Klamath River and its tributaries downstream from the city of Klamath Falls, Oregon, and in the Rogue River (Moyle 2002). They tend to inhabit deep, quiet pools in mainstem rivers and slower-moving reaches in tributaries; however, they can be found in faster-flowing habitats when feeding or breeding (Moyle 2002). McGinnis (1984) reported that this species spawns in small tributaries to the Klamath and Trinity rivers. Spawning in tributaries to has been observed from mid-March to late April (Moyle 2002). Juveniles are most commonly found in the streams that are used for spawning. The larger adults observed have been from fish measuring 18 in, and have been aged through scale analysis as being approximately 15 years old (Scoppetone 1988, as cited in Moyle (2002). Moyle (2002) speculated that dams and diversions have benefitted this species by increasing the availability of its preferred warmer, low-velocity habitat.

Electrofishing conducted by PacifiCorp and ODFW in the J.C. Boyle Peaking Reach revealed the existence of a population of smallscale suckers in moderate velocity habitat, and they were the most prevalent species in the majority of the collected samples (W. Tinniswood, pers. comm., June 2011). J.C. Boyle Dam blocks the migration of smallscale suckers to potential spawning habitat in Spencer Creek. Currently, spawning occurs in the mainstem of the Klamath River where smallscale suckers are subject to flow fluctuations that can displace their broadcast spawning[83] or strand and dry the eggs during power peaking[84] operations (Dunsmoor 2006). Electrofishing in Jenny Creek revealed adult smallscale suckers occupying deep, moderate-velocity habitat among boulders (W. Tinniswood, pers. comm., June 2011).

Non-native Fish Species

Introduced non-native fish species threaten the diversity and abundance of native fish species through competition for resources, predation, interbreeding with native populations, and causing potential physical changes to the invaded habitat (Moyle 2002). Non-native fish species occurring within the Area of Analysis are described below, including descriptions of interactions with native fish species.

[83] Broadcast spawning takes place when suckers release their eggs and sperm into the water, where fertilization occurs externally.
[84] Power peaking is rapid changes in flow associated with hydropower generation.

Yellow Perch

Yellow perch (*Perca flavescens*) prefer weedy rivers and shallow lakes. They are found in reservoirs and ponds along the Klamath River, and are a popular recreational fishery. Optimal temperature for growth is between 71.6 and 80.6°F but yellow perch can survive in temperatures up to 86 to 89.6°F. They can also survive low levels of dissolved oxygen (less than one milligram per liter [mg/L]) but are most abundant in areas with low turbidity, as they are visual feeders. Larval and juvenile yellow perch feed on zooplankton; adults are opportunistic predators that may feed on larger invertebrates and small fish, including younger yellow perch, white bass, and smelt (Knight et al. 1984); and may also prey on larval suckers (USFWS 1993). The preferred habitat of the yellow perch includes large beds of aquatic plants for spawning and foraging; habitat that is common in Lower Klamath Project reservoirs. Their spawning takes place in 44.6 to 66.2°F water in April and May and usually occurs in their second year (Moyle 2002).

Bass and Sunfish

Several species of bass (*Micropterus* spp.) and sunfish (*Lepomis* spp.) have been introduced into the Klamath Basin, including largemouth bass, white and black crappie, bluegill, pumpkinseed, and green sunfish. All are a popular recreational fishery, especially the bass species. Largemouth bass and sunfish prefer lakes, ponds, or low-velocity habitat in rivers, and are mostly found in Lower Klamath Project reservoirs upstream of Iron Gate Dam. They prefer habitats with aquatic vegetation and will spawn in a variety of substrates. They prefer water temperatures above 80.6ºF. Juvenile and adult largemouth bass tend to feed on larger invertebrates and fish (Moyle 2002), potentially including suckers (USFWS 1993). Smaller members of the family, such as sunfish, are opportunistic feeders and eat a variety of aquatic insects, fish eggs, and planktonic crustaceans (Moyle 2002).

Catfish

Several species of catfish have been introduced into the Klamath Basin, including channel catfish (*Ictalurus punctatus*), black bullhead (*Ameiurus melas*), brown bullhead (*Ameiurus nebulosus*), and yellow bullhead (*Ameiurus natalis*) (NRC 2004). Catfish prefer slow moving, warm water habitat. Brown bullhead (*Ameiurus nebulosus*) can tolerate a wide range of salinities and live at temperatures of 32 to 98.6°F, but their optimum temperature range is 68 to 91.4°F. Brown bullhead are most active at night and form feeding aggregations. Catfish are opportunistic omnivores and scavenge off the bottom of their habitat (Moyle 2002).

Trout

Brook trout (*Salvelinus fontinalis)* is an introduced species in the Upper Klamath Basin within the California portion of the Area of Analysis (FERC 2007) found in clear, cold lake and stream habitats. They prefer temperatures between 57.2 and 66.2°F but can survive in temperatures ranging from 33.8 to 78.8°F. Brook trout feed predominantly on terrestrial insects and aquatic insect larvae, though they may also opportunistically feed on other types of prey such as crustaceans, mollusks, and other small fish. Brook trout spawn in the fall and prefer habitats with small-sized gravel and nearby cover (Moyle 2002).

Brown trout (*Salmo trutta*) have also been introduced to the Klamath River and are found in both the Upper and Lower Klamath Basin. Brown trout prefer clear, cold water and can utilize both lake and stream habitats. Like brook trout, they spawn in the fall in streams with areas of clean gravel. Brown trout become piscivorous (fish eaters) once they reach a size where their gape can accommodate small fish available as prey.

American Shad

American shad are an introduced, anadromous fish species found in the Klamath River downstream of Ishi Pishi Falls, and are a popular sport fish. They feed primarily on plankton, mostly mysids and copepods, and occasionally on small fishes such as smelt. Adult American shad spend three to six years in the ocean before returning to spawn in the Klamath River (Pearcy and Fisher 2011). The preferred spawning habitat of the American shad includes sandy or pebbly substrate, water temperatures between 59 and 64.4°F, and where water velocities are less than 0.7 m/s (approximately 2.3 feet per second) (Moyle 2002).

Estuarine Species

The estuary is the mixing zone for freshwater and saltwater from the ocean. The balance of freshwater to saltwater changes over the course of the day with tides and is also strongly influenced by river flows. Due to this, both marine and freshwater species can often be found in different portions of the estuary at various times. All anadromous fish pass through the estuary during their migrations from freshwater to the ocean and back again, and salmonid smolts may rear in the estuary for varying periods of time, prior to moving into the ocean. Surveys in the freshwater portion of the estuary commonly find Klamath speckled dace (*Rhinichthys osculus klamathensis*), Klamath smallscale sucker (*Catostomus rimiculus*), prickly sculpin, and Pacific staghorn sculpin. Other fairly common species include northern anchovy (*Engraulis mordax*), saddleback gunnel (*Pholis ornate*), and bay pipefish (*Syngnathus leptorhyncus*). Other species in the estuary include federally-listed eulachon, state-listed longfin smelt (*Spirinchus thaleichthys*) (described below), non-native Mississippi silversides (*Menidia beryllina*), surf smelt (*Hypomesus pretiosus*), three-spined stickleback (*Gasterosteus aculeatus*), and several species of gobies. Impacts to the estuarine species were assessed based on effects on specific sensitive species such as eulachon and EFH for groundfish and pelagic fish, as described in the Essential Fish Habitat subsection of Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*.

Eulachon

Eulachon is an anadromous fish that occurs in the lower portions of certain rivers draining into the northeastern Pacific Ocean, ranging from northern California to the southeastern Bering Sea in Bristol Bay, Alaska (McAllister 1963, Scott and Crossman 1973, Willson et al. 2006, as cited in NMFS 2010b). The Yurok Tribe consider eulachon a “Tribal Trust Species,” and the fish has major cultural significance (Larson and Belchik 1998). The southern population of Pacific eulachon consists of populations spawning in rivers south of the Nass River in British Columbia, Canada, to and including the Mad River in California (NMFS 2009a). On March 18, 2010, NMFS listed the southern DPS of eulachon as threatened under the ESA (NMFS 2010b). Final critical habitat was designated in October of 2011 and includes the Klamath River Estuary (NMFS 2011). NMFS has issued a draft recovery plan (NMFS 2016b) and has formed a Eulachon Recovery Team to support recovery planning.

Historically, the Klamath River was described as the southern limit of the range of eulachon (Gustafson et al. 2010). Other accounts have described large spawning aggregations of eulachon occurring regularly in the Klamath River (Fry 1979, Moyle et al. 1995, Larson and Belchik 1998, Moyle 2002, Hamilton et al. 2005), and occasionally in the Mad River (Moyle et al. 1995, Moyle 2002) and Redwood Creek in Humboldt County (Moyle et al. 1995). In addition, small numbers of eulachon have been reported from the Smith River (Moyle 2002). The only reported commercial catch of eulachon in northern California occurred in 1963 when a combined total of 25 metric tons (56,000 lbs) was caught from the Klamath River, the Mad River, and Redwood Creek (Odemar 1964). Since 1963, the run size has declined to the point that only a few individual fish have been caught in recent years. Moyle (2002) indicates that eulachon have been scarce in the Klamath River since the 1970s, with the exception of three years: they were plentiful in 1988, 1989, and 1998. After 1998, eulachon were thought to be extinct in the Klamath Basin until a small run was observed in the estuary in 2004. According to accounts of Yurok Tribal elders, the last noticeable runs of eulachon were observed in the Klamath River in 1988 and 1989 by Tribal fishermen (Larson and Belchik 1998).

Larson and Belchik (1998) reported that eulachon have not been of commercial importance in the Klamath since the 1980's. However, in January 2007, six eulachon were reportedly caught by tribal fishermen on the Klamath River. Another seven were captured between January and April of 2011 at the mouth of the Klamath River (McCovey 2011b). More recently, 40 adult eulachon were captured in spring 2012 (McCovey 2012), and 112 in spring 2012 (McCovey and Walker 2013) by Yurok Indian tribal biologists in presence/absence surveys, using seines and dip nets in the Klamath River.

According to the 2016 status review update of southern DPS eulachon (Gustafson et al. 2016), adult spawning abundance of the southern DPS of eulachon has increased since the listing occurred in 2010. A number of data sources indicate that eulachon abundance in some subpopulations within the southern DPS was substantially higher in 2011 through 2015 compared to indications of very low abundance in 2005 through 2010. The improvement in estimated abundance in the Columbia, Naselle, Chehalis, Elwha, and Klamath rivers, relative to the time of listing, reflects both changes in biological status and improved monitoring (Gustafson et al. 2016).

Historically, eulachon runs in northern California were said to start as early as December and January and peak in abundance during March and April. Large numbers of eulachon migrated upstream in March and April to spawn, but they rarely moved more than eight miles inland (NRC 2004). Eulachon spawn at an age of three to five years, and usually die after spawning (Larson and Belchik 1998). Spawning occurs in gravel riffles, with hatching about a month later. The larvae generally move downstream to the estuary following hatching (Larson and Belchik 1998).

Longfin Smelt

Longfin smelt are a state-listed threatened species and a CDFW Species of Special Concern throughout their range in California. The USFWS denied the petition for federal listing because the population in California (and specifically San Francisco Bay) was not believed to be sufficiently genetically isolated from other populations (USFWS 2009). This species generally has a two-year lifespan, although three-year-old fish have been observed (Moyle 2002). They typically live in bays and estuaries and have sometimes been observed in the nearshore ocean from San Francisco Bay to Prince William Sound, Alaska, including the Klamath River. Longfin smelt prefer salinities of 15 to 30 parts per thousand (ppt), although they can tolerate salinities from freshwater to full seawater. They prefer temperatures of 60.8 to 64.4°F and generally avoid temperatures higher than 68°F. Longfin smelt may occur in the Klamath River throughout the year. They would only be expected to use the estuary, the lowest reaches of the river, and infrequently in the Pacific Ocean nearshore. Longfin smelt spawning occurs primarily from January to March, but may extend from November into June, in fresh or slightly brackish water over sandy or gravel substrates. Temperatures during spawning in the San Francisco estuary are 44.6 to 58.1°F. Embryos hatch in approximately 40 days in 44.6°F water temperature (approximately 25 days in 51°F water) and are quickly swept downstream by the current to more brackish areas. The importance of ocean rearing is unknown. Longfin smelt were common in the Klamath River Estuary during 1978–1989, but the population has significantly declined since. In 1992, two were found in the Klamath River Estuary, and in 2001 only one adult longfin smelt was collected (CDFG 2009).

Freshwater Mollusks

While life history traits of individual species of freshwater mussels have not been fully studied, the general life cycle is as follows. Eggs within female freshwater mussels are fertilized by sperm that is brought into the body cavity. From April through July thousands of tiny larvae, called glochidia, are released into the water where they must encounter a host fish for attachment within hours, otherwise they perish (Haley et al. 2007). Most juvenile freshwater mussels from these species drop off the fish hosts to settle from June to early August. The juvenile freshwater mussels spend an undetermined amount of time buried in the sediment where they grow to the point where they can maintain themselves at or below the substrate surface in conditions that are optimal for filter feeding (Nedeau et al. 2009). Freshwater mussels are fed upon by muskrats, river otters, and sturgeon (Nedeau et al. 2009). They are also a food of cultural significance for the Karuk Tribe (Westover 2010) and The Klamath Tribes. Adult freshwater mussels are generally found wedged into gravel rock substrate or partially buried in finer substrates, using a muscular foot to maintain position. Freshwater mussels filter feed on plankton and other organic material suspended in the water column.

Four species of native freshwater mussels have been observed within the Klamath Basin (FERC 2007, Westover 2010). PacifiCorp surveys conducted in 2002 and 2003 found Oregon floater (*Anodonta oregonensis*), California floater (*Anodonta californiensis*) and western ridged mussel (*Gonidia angulata*) along Klamath River reaches from the Keno Impoundment/Lake Ewauna to the confluence of the Klamath and Shasta rivers. Westover (2010) also found western pearlshell mussel (*Margaritifera falcata*) in addition to these species along the Klamath River from Iron Gate Dam to the confluence of the Klamath and Trinity rivers. Byron and Tupen (2017) surveys also conducted during in 2002 and 2003 upstream of Iron Gate Dam documented Oregon floater and western ridged mussel in the Keno Reach, Oregon floater in the J.C. Boyle Peaking Reach, and both species in the mainstem Klamath River between Copco No. 2 Reservoir and J.C. Boyle Dam.

Downstream of Iron Gate Dam, Davis et al. (2013) found that *Anodonta sp.* occurred only in the farthest upstream survey sites; western ridged mussel was present in most reaches and often at high densities, and western pearlshell mussel was present in high numbers downstream of the confluence with the Salmon River. All surveyed mussel populations declined in abundance with increasing distance downstream of Iron Gate Dam, due to more mobile substrate. The Shasta River was the only tributary to the Klamath River with Oregon floater, California floater, and western ridged mussel all detected. Western ridged mussel and western pearlshell mussel were more common in reaches farther downstream in the Klamath River from Iron Gate Dam, probably due to thicker shells which allow them to withstand scouring in high flow events.

A full understanding of western ridged mussels former and current distribution is difficult to assemble due to the lack of data, but it is believed to have been extirpated in central and southern California and has probably declined in many other watersheds, including the Columbia and Snake River basins (Jepsen et al. 2010). The Klamath River appears unusual in that western ridged mussels dominates its mussel community, unlike other rivers in the Pacific Northwest (Westover 2010).

Western pearlshell mussels have also been observed within the Klamath Basin downstream from Iron Gate Dam, though in lesser abundance than other mussel species (Westover 2010). Western pearlshell mussels occupies habitats with low water velocity (e.g., pools and near banks) and pockets within bedrock and cobble (Howard and Cuffey 2003).

Anodonta spp. (commonly referred to as “floaters”) are more tolerant of lake conditions than other native mussel species (Nedeau et al. 2005), and have been observed in Lower Klamath Project reservoirs. Floaters are also more tolerant of siltier substrates, as their thin shells allow individuals to “float,” or rest on top of silt-dominated streambeds. Byron and Tupen (2017) found that low-energy areas where finer sediments accumulate and where hydrology is consistent were most suitable for *Anodonta spp.*

Western ridged mussels are the largest and most common type of freshwater mussel found within the Klamath Basin (Nedeau et al. 2005). They are known to prefer cold, clean water, but can tolerate seasonal turbidity, and can be found in aggrading, or depositional areas as it can partially bury itself within bed sediments without affecting filter feeding (Vannote and Minshall 1982, Westover 2010). Byron and Tupen (2017) found that they appeared to prefer faster waters and, consequently, coarser substrates such as medium- and coarse sands. Even areas with boulder and bedrock substrates had pockets of finer materials in which *G. angulata* were aggregated. Commonly, *G. angulata* were found buried to depths of 15 centimeters and often stacked atop one another. In general, *G. angulata* were always buried at least 80 percent, with only the tops of shells visible (Byron and Tupen 2017). Known fish hosts of juvenile *G angulata* include hardhead (*Mylopharodon conocephalus*), Pit sculpin (*Cottus pitensis*), and tule perch (*Hysterocarpus traski*), but a full list of host fish species for western ridged mussels are unknown (Jepsen et al. 2010). However, Mageroy (2016) found that *G. angulata* hosts in Canada included primarily sculpin species (*Cottus* spp.) but that northern pikeminnow (*Ptychocheilus oregonensis*), leopard dace (*Rhinichthys falcatus*), and longnose dace (*Rhinichthys cataractae*) are potential hosts as well. Therefore, it appears that the species has significant range of hosts.

Seven to eight species of fingernail clams and peaclams (Family: Sphaeriidae) were also found in the Hydroelectric Reach and from Iron Gate Dam to Shasta River during re-licensing surveys (FERC 2007). One of the clam species, the montane peaclam (*Pisidium ultramontanum)*, has special status as a federal species of concern and a USDA Forest Service Sensitive Species. The montane peaclam is generally found on sand-gravel substrates in spring-influenced streams and lakes, and occasionally in large spring pools. The historic range included the Klamath and Pit rivers in Oregon and California, as well as some of the larger lakes (Upper Klamath, Tule, Eagle, and possibly, Lower Klamath lakes) (FERC 2007). On USDA Forest Service lands they are currently present or suspected in streams and lakes of Lassen and Shasta-Trinity National Forests. Fingernail clams and peaclams are relatively short-lived (one to three years) compared to freshwater mussels (typically 10 to 15 years although in some cases 100 or more years for some species). These small clams live on the surface or buried in the substrate in lakes, ponds or streams. They bear small numbers of live young several times throughout the spring and summer (Thorp and Covich 2001).

There are also many species of freshwater snails, some of which are endemic to the Klamath Basin and have restricted ranges, often associated with cold-water springs. Several of these have recently been petitioned for listing. Based on their restricted distribution to areas outside of Klamath River reaches that could be affected by the Proposed Project, no further analysis was undertaken for freshwater snails for this EIR.

Benthic Macroinvertebrates

Benthic macroinvertebrates (BMI) are small aquatic animals and the aquatic larval stages of insects. They lack a backbone, are visible with the naked eye and are found in and around water bodies during some period of their lives. BMI include immature, aquatic stages of insects such as midges, mayflies, caddisflies, stoneflies, dragonflies, and damselflies. They also include immature and adult stages of aquatic beetles; crustaceans such as crayfish, amphipods and isopods ; clams and snails; aquatic worms; and other major invertebrate groups. Many BMI are the primary consumers in riverine food webs, feeding on primary producers—algae, aquatic plants, phytoplankton, bacteria, as well as leaves and other organic materials from terrestrial plants, and detritus. By converting organic material into biomass available to a wide variety of consumers, these organisms form an important component of the aquatic food web. Some BMI are secondary consumers, feeding on the primary consumers. BMI are the primary food source for most freshwater fish species, and therefore, changes in abundance, distribution, or community structure can affect fish populations. BMI are also used as general indicators of water quality. This is assessed based upon the relative abundance or diversity of each group (taxa) and their tolerance of water quality impairment or habitat degradation. BMI are also particularly sensitive to changes in fine and coarse sediment, which would occur during the Proposed Project. A diminished food supply can limit growth of salmonids, and this is especially true at higher temperatures because as water warms, a fish’s metabolic rate increases and it needs more food to sustain growth (Brett 1971, McCullough 1999). Growth is critical to juvenile salmonids because a larger size fish often has a survival advantage during the overwintering period, smolt outmigration, and ocean residence. If fish are chronically exposed to warm water temperatures and food availability is low, growth rates are reduced and fish experience physiological stress, often resulting in increased mortality from disease, parasites, and predation. However, in a productive system with high densities of BMI or forage fish, a high rate of growth can be sustained at temperatures higher than would be considered optimal under conditions where food is limiting.

Relicensing studies for PacifiCorp’s Klamath Hydroelectric Project evaluated BMI populations in the Klamath River from Link River Dam to the Shasta River and within Fall Creek in 2002 and 2003 (FERC 2007). These studies show that BMI are abundant, with typical densities of 4,000 to 8,000 individuals per square meter. BMI densities in the fall of 2002 ranged from approximately 2,200 per square meter in the Copco No. 2 Bypass Reach of the Klamath River to approximately 21,600 per square meter below Keno Dam (FERC 2007). Abundance of BMI in both the J.C. Boyle Peaking Reach of the

Hydroelectric Reach and the Middle Klamath River downstream of Iron Gate Dam was as low as approximately 500 per square meter in the spring of 2003. The Lower Klamath Project reservoirs had high abundance of BMI, but low diversity, and were dominated by species tolerant of impaired water quality conditions.

The Yurok Tribe conducted studies in 2005 and 2008 (Burks and Cowan 2007) evaluating the biological community of the Klamath River within the Yurok Indian Reservation (RM 0 to RM 43.3) through BMI surveys. Data collected during these studies were used to calculate an Index of Biological Integrity (IBI)—composite scores generated by assigning values to variables, such as species richness, percent intolerant individuals, percent predator individuals, and others.

The Index of Biological Integrity values generated in 2005 indicated that two of the nine sites on the Klamath River within the Yurok Indian Reservation were in the “impaired” range (i.e., score of 52 or below), and the majority of the other sites were in “fair” condition (i.e., score of 53 to 60) (Burks and Cowan 2007). In 2008, the Index of Biological Integrity values suggested a slight improvement in stream health, with the majority of sites scoring in the “good” range (i.e., score of 61 to 80) (Sinnott and Hanington 2008).

Marine Mammals

Pinnipeds (seals and sea lions), and Southern Resident Killer Whales potentially occur within the Pacific Ocean nearshore environment, off Northern California. Redwood National Park lists harbor seals (*Phoca vitulina richardsi*), California sea lions (*Zalophus californianus*), Steller sea lions (*Eumetopias jubatus*), and Northern elephant seals (*Mirounga angustirostris*) as occurring at least seasonally in the vicinity of the Klamath River Estuary. Elephant seal diets consist primarily of rays, sharks, pelagic squid, ratfish, and Pacific hake, and are not expected to consume salmonids, but other pinnipeds and Southern Resident Killer Whales may feed on adult salmon from the Area of Analysis. In particular, pinnipeds are a documented predator within the Klamath River Estuary and nearshore environment. During radio telemetry studies, Strange (2007a, 2007b, 2008) found that between 14 and 33 percent of tagged Chinook salmon were consumed by pinnipeds (primarily California sea lions). However, the Chinook salmon tagged in those studies were disoriented and potentially fatigued as a result of being captured, anesthetized, and handled, and were therefore more vulnerable to predation. In these studies, most of the observed predation occurred within minutes to hours of release.

In a study of pinniped predation in the Klamath River Estuary using visual observations in August through mid-November 1998 (Williamson and Hillemeir 2001), approximately 3,077 adult salmon were consumed (including fall-run Chinook salmon, spring-run Chinook salmon, coho salmon, and steelhead). Most predation was on fall-run Chinook salmon (2,559 consumed) and was equivalent to 2.6 percent of the estimated fall-run Chinook salmon run that year. An estimated 438 spring-run Chinook, 63 coho salmon, and 110 steelhead were also consumed. California sea lions were the primary predator, and Pacific harbor seals, and Steller sea lions were also observed feeding upon salmonids. Efforts such as “seal bombs” have been used to reduce pinniped predation on salmonids in the estuary, but have not been observed to be effective (Strange 2008).

Southern Resident Killer Whale

The Southern Resident Killer Whale (*Orcinus orca*) DPS is listed as endangered under the ESA (NMFS 2005). This DPS primarily occurs in the inland waters of Washington State and southern Vancouver Island, although individuals from this population have been observed off coastal California in Monterey Bay, near the Farallon Islands, and off Point Reyes (Heimlich-Boran 1988, Felleman et al. 1991, Olson 1998, Osborne 1999, NMFS 2005). Survival and fecundity of Southern Resident Killer Whales are correlated with Chinook salmon abundance (Ward et al. 2009, Ford et al. 2009). Hanson et al. (2010) found that Southern Resident Killer Whale stomach contents included several different ESUs of salmon, including Central Valley fall-run Chinook salmon, but none from the Klamath River Basin. More recent studies have confirmed that salmon from the Klamath River are consumed, although in small numbers (Hanson 2015). During most of the year Southern Resident Killer Whale are present in Washington inland waters where their diet consists primarily of Chinook salmon. During occasional and short-duration winter visits to the California Coast their diet is primarily chum, Chinook and coho salmon, augmented with smaller numbers of steelhead and sockeye (Hanson 2015). No data are available to determine the contribution of salmon from the Klamath River Basin to their overall diet, but it is believed to be small (<1 percent) on an annual basis given the work of Hanson et al. (2010) and Hanson (2015).

3.3.2.2 Physical Habitat Descriptions

Upper Klamath River and Connected Waterbodies

Aquatic habitat in the Upper Klamath Basin includes both lacustrine (lake) and riverine (river) habitats and large thermally stable coldwater springs. The Upper Klamath River upstream of Iron Gate Dam once supported large populations of anadromous salmon and steelhead by providing spawning and rearing habitat (Hamilton et al. 2005, Butler et al. 2010, Hamilton et al. 2016), as discussed in detail in Section 3.3.5.8 *Aquatic Habitat*.

Upper Klamath Lake is the most prominent feature in this part of the basin, although other lakes and reservoirs are also present. Lake Ewauna, another lake on the Klamath River mainstem, is formed by Keno Dam, which regulates water surface elevations in the impoundment to facilitate agricultural diversions. Lake Ewauna connects to Upper Klamath Lake via the Link River.

Upper Klamath Lake and Lake Ewauna are affected by poor water quality conditions. During the summer months, these waterbodies exhibit episodic high pH, broad daily shifts in dissolved oxygen, and elevated ammonia concentrations (Hamilton et al. 2011). In Upper Klamath Lake several incidents of mass adult mortality of shortnose and Lost River sucker have been associated with low dissolved oxygen levels (Perkins et al. 2000, Banish et al. 2009). Instances of pH levels above 10 and extended periods of pH levels greater than nine lasting for several weeks are associated with large algal blooms occurring in the lake (Kann 2010). On a diel (i.e., 24-hour) basis, algal photosynthesis can elevate pH levels during the day, with changes exceeding two pH units over a 24-hour period. During November through April, pH levels in Upper Klamath Lake are near neutral (Aquatic Scientific Resources 2005).

Implementation of the Proposed Project would result in the reintroduction of anadromous fish into Upper Klamath Lake and Lake Ewauna and their tributary streams. Fish passage over Link Dam is provided by a ladder. This ladder is designed to modern standards to allow the passage of shortnose and Lost River suckers and other migratory fish, including resident and anadromous salmonids and Pacific lamprey, if present. Keno Dam is equipped with a 24-pool weir and orifice type fish ladder, which rises 19 feet over a distance of 350 feet, designed to pass trout and other resident fish species (FERC 2007). The fishway at Keno Dam currently complies with passage criteria for salmonid fish. Although Lost River and shortnose suckers (in addition to other sucker species), have been observed to use the Keno Dam fish ladder, the ladder was not designed for sucker passage and is considered generally inadequate for sucker passage (USBR 2002). Plans are being developed to have the fishway rebuilt to criteria for suckers, lamprey, and for larger anadromous salmonid runs (T. Reaves Gilmore, USBR, pers. comm., October 2018).

The Williamson and Wood rivers are the largest and second largest tributaries to Upper Klamath Lake, respectively. The Sprague River is tributary to the Williamson River, and the Sycan River is tributary to the Sprague River (Hamilton et al. 2011). These tributaries currently provide habitat for redband trout, bull trout, shortnose sucker and Lost River sucker, as well as other species. Historically these tributaries provided substantial habitat for Chinook salmon and steelhead (Hamilton et al. 2005, 2016). Important flow contributions from springs into these tributaries provide cool summer baseflows with water temperatures and dissolved oxygen levels generally adequate to support coldwater fish habitat requirements (Hamilton et al. 2011).

Upper Klamath River – Hydroelectric Reach

The Hydroelectric Reach, from the upstream extent of J.C. Boyle Reservoir to Iron Gate Dam, includes four reservoirs (J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate) and two riverine reaches. Several coldwater tributaries enter the Klamath River and reservoirs in this reach. The reservoirs are productive and nutrient rich and tend to have warm surface waters during the summer months, with mean daily temperatures sometimes reaching 73ºF (FERC 2007). During the late spring/early summer, water quality in Copco No. 1 and Iron Gate reservoirs declines, becoming quite poor due to warm surface waters and annual blooms of the blue-green algae species *Aphanizomenon flow-aquae, Anabaena flos-aquae,* and *Microcystis aeruginosa* (see also Section 3.4 *Phytoplankton and Periphyton*). *Microcystis aeruginosa,* and to an unknown extent *Anabaena flos-aquae,* produce toxins that can be harmful to fish and other animals and humans. Routine sampling from areas frequented by recreational users of the reservoirs has documented cell counts up to 4,000 times greater than what the World Health Organization considers a moderate health risk (see Section 3.4 *Phytoplankton and Periphyton*). This has resulted in Copco No. 1 and Iron Gate reservoirs being posted with health advisory warnings against human and animal contact with the water by local health officials every summer since 2005.

The 21-mile long riverine reach between J.C. Boyle and Copco No. 1 reservoirs is divided into two reaches: the 4.6-mile long J.C. Boyle Bypass Reach, which receives bypass flows from J.C. Boyle Dam, and the 17-mile long Peaking Reach, which receives variable flow from hydroelectric operations (see also Section 2.3.1 *J.C. Boyle Dam and Associated Facilities*). The downstream 6.2 miles in California is designated by CDFW as a Wild Trout Area with the whole reach managed by CDFW for wild trout, including angling restrictions and reduced stocking, and habitat enhancements targeted for native trout (CDFG 2005). The reach from the J.C. Boyle Powerhouse to the Oregon-California state line is designated as a National Wild and Scenic River. Approximately 100 cubic feet per second (cfs) is released from J.C. Boyle Dam to the Bypass Reach through a minimum flow outlet and the fish ladder. This is augmented by inflows from Big Springs of about 220 to 250 cfs (FERC 2007). In the Peaking Reach, this flow is added to flows from the powerhouse, which can range from zero to over 3,000 cfs, depending on operations (FERC 2007). Peaking operations can occur daily, or cycles may extend over several days, depending on water availability, power demands, and whitewater boating needs. The 1.4-mile Copco No. 2 Bypass Reach has flows of about 5 cfs provided by Copco No. 2 Dam. Both of these riverine reaches provide complex physical habitat suitable for salmonid spawning and rearing.

A number of tributary streams join the Klamath River in this reach, including Spencer, Shovel, Fall, Spring, and Camp creeks. These streams provide suitable coldwater spawning and rearing habitat for fish (including potentially salmon and steelhead).

As described in detail in Section 3.20.2.3 *Lower Klamath Project Reservoir-Based Recreation*, the reservoirs currently provide a recreational fishery for non-native fishes including largemouth bass, trout, catfish, crappie, and sunfish (Hamilton et al. 2011). Fishing is popular in Copco No. 1 and Iron Gate reservoirs, especially for yellow perch (Hamilton et al. 2011). These reservoirs also support small numbers of native shortnose and Lost River suckers that are believed to be individuals that have migrated down from the upstream reservoirs and that are thought to not be self-sustaining populations or to be contributing to populations in upstream areas (Hamilton et al. 2011). Riverine sections between reservoirs support populations of speckled dace, marbled sculpin, tui chub, and rainbow and redband trout. This area historically supported anadromous fish populations, including Chinook and coho salmon, steelhead, and Pacific lamprey. These fish can no longer access this area because of the lack of adequate facilities for fish passage at the dams (Hamilton et al. 2011).

Middle and Lower Klamath River

The Klamath River flows unobstructed for 190 river miles downstream from Iron Gate Dam before entering the Pacific Ocean. Downstream from Iron Gate Dam, the Klamath River has a gradient of approximately 0.25 percent and four major tributaries enter this reach: Shasta, Scott, Salmon, and Trinity rivers.

The Klamath Basin downstream from Iron Gate Dam provides hundreds of miles of suitable habitat for anadromous and resident fish. Recreational fishing within this area is popular for steelhead and Chinook salmon, and tribal fishing is common for Chinook salmon with gillnets, and Pacific lamprey with basket traps. Freshwater mussels are also common in this reach. Most of the anadromous salmonid species spawn primarily in the tributary streams, although fall-run Chinook salmon and coho salmon do spawn in the mainstem. The mainstem also serves as a migratory corridor and as rearing habitat for juveniles of many salmonid species (FERC 2007). The ability of the mainstem Klamath River to support the rearing and migration of anadromous species is reduced by periodic high water temperatures during summer, poor water quality (low dissolved oxygen and high pH; see Sections 3.2.2.5 *Dissolved Oxygen* and 3.2.2.6 *pH*), and disease outbreaks during spring. Aquatic habitat quality in the tributaries is also affected by high temperatures. The Shasta and Scott Rivers also are impaired by low flows, high water temperatures, stream diversions, non-native species, and degraded spawning habitat (Hardy and Addley 2001, FERC 2007, North Coast Regional Board 2010). In the Salmon River, past and present high severity fires and logging roads in the watershed contribute to high sediment yields, and continued placer mining has disturbed spawning and holding habitat (NRC 2004).

Klamath River Estuary

Wallace (1998) surveyed the Klamath River Estuary and noted formation of a sand berm at the river mouth each year in the late summer or early fall, raising the water level in the estuary, reducing tidal fluctuation, and restricting saltwater inflow. The surveys found a brackish water layer along the bottom of the estuary may be extremely important to rearing juvenile salmonids, as they appeared to be more abundant near the freshwater/saltwater interface. Juvenile Chinook salmon may also use the cooler brackish water layer as a thermal refuge.

The Klamath River Estuary supports a wide array of fish species and also serves as breeding and foraging habitat for marine and estuarine species. These species include, but are not limited to Pacific herring (*Clupea pallasii*), surf smelt, longfin smelt, eulachon, top smelt, starry flounder (*Platichthys stellatus*) and other flatfish, Klamath speckled dace, Klamath smallscale sucker, prickly sculpin, Pacific staghorn sculpin, northern anchovy, saddleback gunnel, and bay pipefish. Recreational fishing for Chinook salmon is popular in the estuary, as well as tribal fishing for Chinook salmon with gillnets and Pacific lamprey with hooks.

Pacific Ocean Nearshore Environment

The Pacific Ocean nearshore environment includes the Klamath River Management Zone (KMZ), the California portion of which extends from the Oregon-California state line south to Horse Mountain (40° 05' 00" N. latitude) and out three nautical miles from the coast. Physical habitat within this environment includes sandy beach, rocky intertidal, and a sand-dominated seafloor at depths less than 200 ft within one mile of the coast, ranging to depths greater than 500 ft on the continental shelf. During winter high flows fine sediment deposits on the seafloor shoreward of the 196-feet isobath along the coast, with greater quantities depositing in close proximity to the mouth of the Klamath River. After fine sediment loading onto the continental shelf during river floods, fluid-mud gravity flows typically transport fine sediment offshore. Summer coastal upwelling naturally resuspends some of the river sediments that are transported to the nearshore environment and deposited on the continental shelf, especially those deposited during the previous winter (Ryan et al. 2005, Chase et al. 2007; see Potential Impact 3.2-8).

The Pacific Ocean nearshore environment supports a wide array of fish species and serves mostly as foraging habitat for marine and anadromous species. These species include, but are not limited to all of the anadromous fish listed previously, as well as federally threatened Southern DPS green sturgeon, Pacific halibut (*Hippoglossus stenolepis*), Pacific herring, surf smelt, longfin smelt, eulachon, top smelt, starry flounder and other flatfish, northern anchovy, saddleback gunnel, lingcod (*Ophiodon elongates*), rockfish species (*Sebastes spp.*). Within the Pacific Ocean nearshore, recreational and commercial fishing for Chinook salmon, halibut, lingcod, and rockfish species is common.

3.3.2.3 Habitat Attributes Expected to be Affected by the Proposed Project

The Proposed Project would affect the physical, chemical, and biological components of aquatic habitat within portions of the Klamath Basin. These effects would result from changes in suspended sediment, bedload sediment, water quality, water temperature, disease and parasites, habitat availability, and flow-related habitat. As described in the following sections, these changes would act in both beneficial and harmful ways on species, critical habitat, and EFH. Some of the changes would be short-term, and others permanent. The overarching long-term effect would be to bring the habitat closer to a more natural riverine system, from the current reservoir and reservoir-influenced baseline.

Appendices E and F provide more detailed technical descriptions of suspended sediment and bedload sediment under existing conditions. Anticipated changes in water quality under the Proposed Project are discussed in greater detail in Section 3.2 *Water Quality*, and a description of the effects of implementing the Proposed Project on algae is found in Section 3.4 *Phytoplankton and Periphyton*.

Suspended Sediment

Suspended sediment dynamics would be altered by the Proposed Project within the Hydroelectric Reach and reaches downstream of Iron Gate Dam. Existing conditions with respect to algal-derived (organic) suspended material and mineral (inorganic) suspended material in the Klamath River upstream and downstream from Iron Gate Dam are summarized in Section 3.2.2.3 *Suspended Sediments* and in Appendix C.

Hydroelectric Reach

Organic suspended material originating from Upper Klamath Lake (in Oregon) is the predominant form of suspended material entering the Hydroelectric Reach. Interception, decomposition, and retention of suspended materials in the Lower Klamath Project reservoirs, as well as dilution from coldwater springs downstream of J.C. Boyle Dam, can decrease organic suspended material concentrations in this reach; however, seasonal increases in organic suspended material also occur in Copco No. 1 and Iron Gate reservoirs due to large summertime phytoplankton blooms (see Section 3.2.2.3 *Suspended Sediments* and Appendix C – *Section C.2.1* for more detail). In the winter months, suspended material in the Hydroelectric Reach is dominated by mineral sediment loads from several tributaries that join the river in this reach (primarily Shovel Creek, Spencer Creek, Jenny Creek, and Fall Creek), which are primarily transported during high flow events and generally settle out in the Lower Klamath Project reservoirs. On the scale of the entire Klamath Basin, the trapping of fine sediments and suspended materials does not appear to be a critical function of the Lower Klamath Project reservoirs with respect to the overall cumulative sediment delivery including downstream tributaries (see also Section 3.11.2.4 *Sediment Load*), since a relatively small percentage (3.4 percent) of total sediment supplied to the Klamath River on an annual basis originates from the Upper and Middle Klamath River (i.e., from J.C. Boyle Dam to the confluence with the Shasta River).

Middle and Lower Klamath River

In general, available data (existing conditions) (detailed in Appendix C.2.2.1) indicate that suspended sediment concentrations (SSCs) downstream from Iron Gate Dam range from less than 5 mg/L during summer low flows to greater than 5,000 mg/L during winter high flows. During large winter storms or following landslides in the Klamath Basin, extremely high SSCs have been observed in the Klamath River mainstem and tributaries (M. Belchik, Fisheries Biologist, Yurok Tribe, pers. comm., August 2008). Large rivers such as the Klamath River, Columbia River, and Sacramento River have large fluctuations in SSCs even under unimpaired conditions, and aquatic species have adapted to survive in this environment. Appendix E provides a detailed analysis of the effects of suspended sediment on aquatic species downstream from Iron Gate Dam under existing conditions.

During all water year types, SSCs of the magnitude and duration modeled under existing conditions (multiple months with concentrations over 50 mg/L) are expected to cause major stress to migrating adult and juvenile salmonids primarily during winter and early spring (Newcombe and Jenson 1996, see also Appendix E). Under existing conditions, Iron Gate Dam traps most suspended sediment from upstream sources, and downstream of Iron Gate Dam SSCs generally increase in a downstream direction from the contribution of tributaries (Appendix C.2).

Klamath River Estuary
Under existing conditions, SSCs within the Klamath River Estuary (modeled at Klamath Station at RM 5; Figure 3.3-1) are relatively high compared to SSCs observed farther upstream due to SSC contribution of major tributaries downstream of Iron Gate Dam (Appendix E). The Lower Klamath River downstream from the Trinity River confluence to the estuary is currently listed as sediment-impaired under Section 303(d) of the Clean Water Act (CWA) (North Coast Regional Board 2010). Modeling in the Klamath River (from Seiad Valley at approximately RM 132.7 downstream to the Klamath Station at RM 5) indicates that under normal conditions SSCs are relatively high during winter and spring (typically 50 to 100 mg/L), and lower (less than 10 mg/L) during summer. Under existing extreme conditions (wet water year) SSCs are generally 10 to 100 mg/L in summer and fall, with peaks between 100 and 1,000 mg/L during winter and spring.

Pacific Ocean Nearshore Environment
Under existing conditions, a plume of Klamath River water extends into the Pacific Ocean nearshore environment in the Klamath River vicinity that is subject to strong land runoff effects following winter rainfall events. The plume can create areas of low-salinity, high levels of suspended particles, high sedimentation, and low light, and potential exposure to land-derived contaminants (Farnsworth and Warrick 2007). The extent and shape of the plume is variable, and influenced by wind patterns, upwelling effects, shoreline topography (especially Point Saint George), and longshore currents. High riverine SSC events contribute to the plume, especially during floods. In northern California, plume zones are primarily north of river mouths because longshore currents and prevailing winds are northward during periods of strong runoff (Geyer et al. 2000, Pullen and Allen 2000). River plumes and the associated habitat conditions they create support areas of high productivity for marine organisms (Grimes and Finucane 1991, Morgan et al. 2005), and create abrupt changes in marine water quality conditions (e.g., water temperature, salinity, sediment) that support salmonids (Schabetsberger et al. 2003, De Robertis et al. 2005).

Bed Elevation and Grain Size Distribution
Section 3.11.2.4 *Sediment Load* and Appendix F of this EIR describe sediment dynamics and channel conditions in the Area of Analysis and assess changes in channel bed elevation and sediment grain size in response to increased bedload supply and transport for existing conditions and under the Proposed Project. The sections below provide a brief summary of the analyses of bedload supply, transport, and channel change provided elsewhere. Bedload supply and transport are vital to the creation and maintenance of functional aquatic habitat. Natural river dynamics include transportation of coarse sediment (e.g., sand, gravel, cobble, and boulder) downstream. Natural sediment pulses that result from heavy rainfall and snowmelt events are incorporated by stream and river processes into spawning beds, gravel bars, side channels, pools, riffles, and floodplains that provide habitat and support food chains of aquatic species. These periodic inputs and movement of coarse sediment are necessary for the long-term

maintenance of aquatic habitats. Salmonids evolved to depend on continued sediment delivery to provide substrate suitable for spawning and early rearing in streams and rivers. These natural processes have been disrupted in the Klamath River since the construction of dams.

Under existing conditions, dams have disrupted geomorphic and vegetative processes that can form channels and create spawning grounds downstream from Iron Gate Dam, by trapping sediment and preventing its transport downstream (Buer 1981, PacifiCorp 2004a, KRBFTF 1991). Since the construction of the Lower Klamath Project, sediment and gravel have been intercepted by Lower Klamath Project reservoirs, with Iron Gate Dam cutting off sediment supply from the Upper Klamath Basin. The resultant reduction in spawning gravels downstream of Iron Gate Dam has been identified as one of the causes of the decline in salmonid fry production in this reach of the Klamath River (Buer 1981). In response to this recognized limiting factor, the California Department of Water Resources developed (but never implemented) gravel augmentation programs for spawning gravel downstream from Iron Gate Dam (Buer 1981). Per the interim operations of the Klamath Hydroelectric Project HCP (PacifiCorp 2012), PacifiCorp developed and implemented a plan to augment gravel immediately downstream of Iron Gate Dam beginning in 2014 (PacifiCorp 2014). Per the interim operations of the Klamath Hydroelectric Project HCP (PacifiCorp 2012), PacifiCorp developed and implemented a plan to augment gravel immediately downstream of Iron Gate Dam beginning in 2014 (PacifiCorp 2014). Gravel augmentation occurred immediately downstream of Iron Gate Dam in 2014, 2016, and 2017, with approximately 4,600 cubic yards total placed downstream of the dam as of December 2017 (PacifiCorp 2018). The placed gravel has been moved downstream by high flows (PacifiCorp 2018), although additional details on the extent of downstream movement have not been reported.

Water Quality

Section 3.2.2 *[Water Quality] Environmental Setting* provides information regarding existing conditions for water quality from J.C. Boyle Reservoir to the Klamath River Estuary, including those parameters that can directly affect beneficial uses for aquatic species (i.e., water temperature, suspended sediments, dissolved oxygen, pH, and algal toxins such as microcystin). Multiple waterbodies in the Area of Analysis, including the mainstem of the Klamath River, are listed under section 303(d) of the CWA for a variety of water quality parameters such as water temperature, sediment, nutrients, dissolved oxygen, pH, ammonia, chlorophyll-*a*, and microcystin (North Coast Regional Board 2011). Existing conditions for water temperature and algal toxins are evaluated in greater detail below with respect to implications on fish health and survival in the Klamath Basin. Microcystin toxin concentrations are also addressed in Section 3.2 *Water Quality* and Section 3.4 *Phytoplankton and Periphyton*.

Water Temperature

The Klamath River, from Keno Dam to the Klamath River Estuary, has been listed as impaired for water temperature (North Coast Regional Board 2011; see Section 3.2 *Water Quality* and Appendix C.1 of this EIR for discussion of existing water temperature conditions). Water temperatures in the Klamath River are of special concern as they are elevated with a greater frequency and remain elevated for longer periods of time than temperatures in adjacent coastal anadromous streams, and they are unsuitable in the lower mainstem for anadromous salmonids at times during the summer (Bartholow 2005). Acute thermal effects for salmonids are expected to occur as mean daily water temperatures begin to exceed 68°F (Bartholow 2005). These elevated temperatures are especially detrimental to anadromous species during the warmer portions of the year (ODEQ 2002). Bartholow (2005) expressed concern that if observed increases in water temperature over the last several decades in the mainstem Klamath River downstream from Iron Gate Dam, which may be related to the cyclic Pacific Decadal Oscillation, continue, some stocks may decline to levels insufficient to ensure survival of the population. Klamath River salmonids are generally more tolerant of high water temperatures than salmonids from other basins (FERC 2007, Foott et al. 2012). Moreover, NMFS (2006a) concluded that available evidence indicates that juvenile steelhead can withstand incrementally higher temperatures exceeding 71.6°F provided food is abundant and by finding thermal refuge or by living in areas where nocturnal temperatures drop below the thermal threshold. Elevated temperatures can affect the timing of different life-history events, altering migration patterns, delaying and shortening the spawning season, impairing reproductive success, reducing growth, and resulting in a reduction of the diversity in the timing of migration (Hamilton et al. 2011). High water temperatures can contribute to low dissolved oxygen events by reducing dissolved oxygen solubility and accelerating oxygen-demanding processes, and can facilitate the spread of disease (Wood et al. 2006). Stress associated with high water temperatures can make cold water species more vulnerable to disease and parasites, and have been associated with fish kills in the Klamath River downstream from Iron Gate Dam during low flow periods in late summer (Hardy and Addley 2001).

Upper Klamath River and Connected Waterbodies

Both Upper Klamath Lake and the Keno Impoundment/Lake Ewauna are relatively shallow and temperatures in both are generally warm during the late spring through early fall (FERC 2007). In the summer, instantaneous maximum water temperatures of 71.6 to 75.2°F are common in the upper three to six feet of Upper Klamath Lake, and temperatures can approach a maximum of 86°F near the surface (PacifiCorp 2004c). Although prolonged exposure to these high temperatures could be lethal for some species, the water temperature remains within tolerance criteria for migrating adult anadromous salmonids during migratory periods (i.e., not during summer) (Dunsmoor and Huntington 2006, Hamilton et al. 2011). Anadromous salmonids successfully navigated through Upper Klamath Lake to spawn in the Upper Klamath Basin prior to their access being blocked by the Lower Klamath Project. Temperatures in Upper Klamath Lake are cooler than those in the Klamath River downstream from Iron Gate Dam in the late summer and early fall when fall-run Chinook salmon are migrating. In addition, thermal refugia are available in this reach where fish can avoid high water temperatures. Upper Klamath Lake supports a population of redband trout that moves into cooler tributary habitats during the summer, but which have high growth rates while in the lake. Those in the lake over the summer can find thermal refuge in Pelican Bay, which is fed by springs and remains cool (Dunsmoor and Huntington 2006). Wetlands surround this bay and would be expected to provide juvenile salmonids with suitable rearing habitat (Dunsmoor and Huntington 2006).

The Keno Impoundment/Lake Ewauna has generally poor water quality in the summer, with instantaneous maximum water temperatures exceeding 77°F and low dissolved oxygen (Hamilton et al. 2011). These warm temperatures are also present downstream from Keno Dam. However, from November through mid-June, the reach from Link River Dam to Keno Dam is cooler (below 68°F) and meets criteria for migrating adult anadromous salmonids (Hamilton et al. 2011). Temperatures in the Link River and the Keno Impoundment/Lake Ewauna tend to increase in the summer; however, maximum water temperatures (71.6 to 77°F) are still within the preferred range for warm- and some cold-water species found in the Upper Klamath Basin (yellow perch, catfish, sunfish, largemouth bass, and spotted bass).

Upper Klamath River – Hydroelectric Reach
Water temperatures in the Hydroelectric Reach are generally warm in the Lower Klamath Project reservoirs from late spring through early fall, but tributaries in this reach are generally cool. In addition, numerous cold-water springs contribute flows to both Copco No. 1 and Iron Gate reservoirs. Average monthly water temperatures within reservoirs from 2001 to 2004 ranged from just over 41°F in November to more than 71.6°F in June through August (FERC 2007), with thermal stratification in Copco No. 1 and Iron Gate reservoirs resulting in relatively warm discharge waters during summer months. Water temperatures at the downstream end of the J.C. Boyle Bypass Reach and in the Klamath River upstream of Shovel Creek are consistently cooler than other sites sampled between Link Dam and the Shasta River (PacifiCorp 2004b). Temperatures in the J.C. Boyle Bypass Reach are cooled by the contribution of 200 to 250 cfs of groundwater at a relatively constant 51.8 to 53.6°F within the reach (PacifiCorp 2006, Kirk et al. 2010). The input from the Bypass Reach during the summer results in a relatively lower daily water temperature range in the Klamath River in the J.C. Boyle Peaking Reach (FERC 2007).

Further downstream in the Peaking Reach, near the confluence of the Klamath River and Shovel Creek (Figure 3.3-1), there are natural hot springs that contribute flows to the mainstem river. The natural hot springs were not found to result in consistent substantial warming of the Klamath River based on two sets of measurements made in November and December 2017 (KRRC 2018). Water temperature data collected upstream and downstream of the confluence of the Klamath River and Shovel Creek showed a 1.4˚F increase in the downstream direction during the November 2017 measurement, but a 0.2˚F decrease during the December 2017 measurement (KRRC 2018). Water temperatures in Shovel Creek itself are generally low year-round, with reported values consistently below 59°F in the summer (PacifiCorp 2004a). Water temperatures recorded in Shovel Creek in late fall/early winter 2017 were 46°F (on November 1) and 39.9°F (December 5) (KRRC 2018).

Temperature data for other tributaries entering the Hydroelectric Reach are based on a limited study period (between 2001 and 2003) (PacifiCorp 2004c). Fall Creek, which flows into Iron Gate Reservoir, is generally cold year-round and does not exceed 57.2°F during the summer (PacifiCorp 2004c). Temperatures in Jenny Creek, which also flows into Iron Gate Reservoir, vary seasonally, ranging from less than 50°F in the spring to more than 71.6°F in July and August (PacifiCorp 2004c). As noted above, temperatures in Shovel Creek are generally low year-round and do not exceed 59°F in the summer (PacifiCorp 2004c). Spencer Creek temperatures are low during spring (<59°F) and are generally below 64.4°F, but can exceed 68°F for short durations (PacifiCorp 2004c).

Iron Gate and Copco No. 1 reservoirs are the two deepest reservoirs in the Hydroelectric Reach. These reservoirs thermally stratify each year beginning in April/May and the warmer (64.4°F to 73.4°F) surface and colder (46.4°F to 62.6°F) bottom waters do not mix again until October/November (see also Section 3.2.2.2 *Water Temperature*). Surface waters in these reservoirs reach maximum temperatures exceeding 77°F during the summer (PacifiCorp 2004c). Colder water temperatures occur at depths greater than six to ten meters below the reservoir surfaces during periods when the reservoirs are stratified (see Appendix C, Section C.1.1.1 and Figure C-1) (PacifiCorp 2004c, Asarian and Kann 2011). The powerplant intakes in both reservoirs are relatively shallow, at approximately nine to ten meters below the surface, such most of the reservoirs' discharge waters are from the warmer surface waters. Consequently, discharges from Copco No. 1 and Iron Gate reservoirs increase late summer/fall water temperatures downstream of Iron Gate Dam by approximately 4°F to 18°F (approximately 2°C to 10°C) (see also *Middle and Lower Klamath River*). Further, even though Copco No. 1 and Iron Gate reservoirs retain large volumes (approximately 9,000 acre-feet and 23,000 acre-feet, respectively) of colder bottom waters during periods of stratification, these waters are typically hypoxic (dissolved oxygen less than 2 mg/L), particularly in Copco No. 1 Reservoir (Appendix C, Section C.4.1.1). Although summertime water temperatures documented in the Hydroelectric Reach are within the tolerance ranges of the species observed there (e.g., perch, bass), these temperatures regularly exceed the range of chronic effects temperature thresholds (approximately 55 to 68°F [13 to 20°C]) for full salmonid support in California (North Coast Regional Board 2010).

Middle and Lower Klamath River

The large thermal mass of the stored water in Copco No. 1 and Iron Gate reservoirs delays the natural warming and cooling of riverine water temperatures on a seasonal basis such that spring water temperatures in the Middle Klamath River immediately downstream of Iron Gate Dam are generally cooler than would be expected under natural conditions, and summer and fall water temperatures are generally warmer (Figure 3.2-3; see also Section 3.2.2.2 *Water Temperature*). This "thermal lag" diminishes downstream from Iron Gate Dam, and there is no noticeable alteration in water temperatures by just upstream of the Salmon River confluence. Summer weather conditions can be very hot from June through September and rising ambient air temperatures can lead to increased water temperatures (Hamilton et al. 2011). Downstream from Iron Gate Dam, monthly mean temperatures in the river are 37.4 to 42.8°F in January and 68 to 72.5°F in July and August (Bartholow 2005). Substantial losses of juvenile salmonids have occurred during their migration through the Lower Klamath River, and losses were especially severe during low-water years with periods of sustained high-water temperatures. Exposure to high water temperature reduces the resistance of these fish to disease and other stressors (Scheiff et al. 2001, Ray et al. 2014). Consequently, during periods of high water temperature juvenile salmonids have been observed to crowd into areas with suitable water temperature such as at tributary confluences (thermal refugia). Summary statistics compiled by the United States Environmental Protection Agency (USEPA) indicate that water temperatures at locations between Iron Gate Dam and the Klamath River's confluence with the Scott River range from about 60.8 to 71.6°F in June, and from 60.8 to 78.8°F in July (FERC 2007). From May through September (peaking in June–August) summer water temperatures in the Lower Klamath Basin begin to warm to stressful levels for cold water species such as salmon, steelhead, and Pacific lamprey.

Klamath River Estuary and Pacific Ocean Nearshore Environment

Water temperatures in the estuary range from 41 to 53.6°F from December through April (Hiner 2006). Warmer air temperatures and lower flows in summer and fall months result in increased water temperatures ranging from 68 to 75.2°F (Wallace 1998) or greater than 75.2°F (Hiner 2006). When flows become low during some summer conditions, water temperatures in the Klamath River Estuary sometimes exceed criteria for optimal growth, and occasionally are warm enough to result in potential mortality for Chinook salmon, coho salmon, and steelhead (Stillwater Sciences 2009a). However, observed warm water conditions in the Klamath River Estuary are typically short in duration, due to input of cool ocean water and a high prevalence of coastal fog. Water temperatures in the Pacific Ocean nearshore environment are moderated by the Pacific Ocean currents and patterns that appear unrelated to the contribution of the Klamath River.

Disease and Parasites

Fish diseases, specifically the myxozoan parasites *Ceratomyxa shasta* (*C. shasta*) and *Parvicapsula minibicornis (P. minibicornis),* regularly result in substantial mortality of Klamath River salmon (Fujiwara et al. 2011, True et al. 2013); however, steelhead are generally resistant to *C. shasta*. Additional diseases that may affect fish in the Klamath Basin include *Ichthyophthirius multifis* (Ich) and *Flavobacterium columnare* (columnaris). These parasites and diseases occur throughout the watershed but appear to cause the most severe mortality in the mainstem Klamath River downstream from Iron Gate Dam where *C. shasta* has been observed to result in high rates of mortality in salmon (True et al. 2013). Ich and columnaris occasionally result in substantial mortality (e.g., the 2002 fish kill of primarily adult Chinook salmon, as discussed below).

Both *C. shasta* and *P. minibicornis* spend part of their life cycle in an invertebrate host and another part in a fish host (Figure 3.4-9). Transmission of these parasites is limited to areas where the invertebrate host is present. In the Klamath River, their invertebrate host is the annelid polychaete worm *Manayunkia speciosa* (Bartholomew et al. 1997, 2007). Once the polychaetes are infected, they release *C. shasta* and *P. minibicornis* actinospores into the water column. Actinospores are generally released when temperatures rise above 50°F and remain viable from three to seven days at temperatures from 51.8 to 64.4°F, with temperatures outside that range resulting in a shorter period of viability (Foott et al. 2007). The longer the period of viability, the wider the distribution of the actinospores within the river, and thus the higher the risk of exposure for salmon (Bjork and Bartholomew 2010). Actinospore abundance, a primary determinant of infectious dose, is controlled by the number of polychaetes and the prevalence and severity of infection within their population. The river channel downstream from Iron Gate Dam has been atypically stable since dam construction, and has provided favorable habitat for the polychaete worm host, likely increasing the parasite load to which the fish are exposed. High parasite loads are believed to lead to higher rates of mortality (Fujiwara et al. 2011). Ray et al. (2014) evaluated *in situ* juvenile salmonid exposure using sentinel cages. Studies found that increasing parasite concentrations and water temperatures were positively associated with the proportion of juvenile fish that experienced infection and mortality. Spore concentration and water temperature were more important determinants of exposure and mortality of juvenile Chinook and coho salmon, than was river flow. The location of peak actinospore concentrations varies among years, and Som et al. (2016a) report that the most frequent location of the peak in concentrations occurs near the confluence of Beaver Creek.

Figure 3.3-2. Lifecycle of *Ceratomyxa shasta*. Source: NMFS 2012.

Salmon become infected when the actinospores enter the gills, eventually reaching the intestines where the parasite replicates and matures to the myxospore stage. Myxospores are shed by the dying and dead salmon, and the cycle continues with infection of polychaete worms by the myxospores (Figure 3.4-9) (Bartholomew and Foott 2010). Som et al. (2016a) states that myxospores released from adult salmon carcasses contribute the bulk of myxospores to the system; mostly from carcasses upstream of the confluence with the Shasta River.

The polychaete host for the parasite is present in a variety of habitat types, including runs, pools, riffles, edge-water, and reservoir inflow zones, as well as sand, gravel, boulders, bedrock, aquatic vegetation, and it is frequently found among mats of filamentous periphytic algal species (e.g., Cladophora) that traps fine sediment and detritus (Bartholomew and Foott 2010).

The highest densities of polychaetes have been observed in slow-flowing and more stable, depositional habitats (e.g., pools with sand) (Bartholomew and Foott 2010), especially if instream flows remain constant. The mobilization of particles on the bed of the channel downstream from Iron Gate Dam depends directly upon the size of the substrate and magnitude of peak flows. The greater the flows, the larger the particles likely to be moved, and the smaller the particle, the lower the flow required for mobilization. Polychaetes are more persistent if the substrate remains immobile for long periods (on the order of years). Under historical conditions, frequent flood events and natural sediment supply, combined with considerable intra-annual flow variability, ensured that the substrate was frequently mobilized. Under existing conditions with dams in place, sediment supply is reduced, flow variability is decreased, and conditions supporting the persistence of polychaetes are more prevalent (Shea et al. 2016).

Susceptibility to *C. shasta* is also influenced by the genetic type of *C. shasta* encountered by the fish (Som et al. 2016a). Atkinson and Bartholomew (2010) conducted an analysis of the genotypes of *C. shasta* and the association of these genotypes with different salmonid species, including Chinook and coho salmon, steelhead, rainbow trout, and redband trout. In a genetic analysis, the *C. shasta* genotypes were characterized as Type 0, Type I, Type II, and Type III (Table 3.3-10). In the Williamson River, although parasite densities had been found to be high, sentinel Chinook salmon were resistant to infection because the genotype specific to Chinook salmon was absent (Hurst et al. 2012).

Table 3.3-10. *Ceratomyxa Shasta* Genotypes in the Klamath Basin.

***C. shasta* Genotype**	**Distribution**	**Affected Species**	**Notes**
Type 0	Upper and Lower Klamath Basin	native steelhead, rainbow, and redband trout	Usually occurs in low densities, is not very virulent, and causes little or no mortality
Type I	Lower Klamath Basin	Chinook salmon	If the Type I genotype were carried into the Upper Klamath Basin, only Chinook salmon would be affected
Type II	Klamath Lake, Upper and Lower Klamath Basin	coho salmon in Lower Klamath Basin and non-native rainbow trout	The "biotype" found in the Upper Klamath Basin does not appear to affect coho salmon in sentinel studies
Type III	Assumed widespread in Klamath Basin based on presence in fish	all salmonid species	Prevalence of this genotype is low and it infects fish but does not appear to cause mortality

Native populations of salmonids in waters where *C. shasta* is endemic generally develop a high degree of resistance to the disease. Stocking et al. (2006) conducted studies of the seasonal and spatial distribution of *C. shasta* in the Klamath River. The study included the exposure of fall-run Chinook salmon (Iron Gate Hatchery strain). The study found the polychaete host, *M. speciosa*, from Upper Klamath Lake to the mouth of the river. Although infection rates were high in non-native, non-resistant rainbow trout, used as sentinel fish in the upper Klamath River upstream of Iron Gate Dam and downstream from the Williamson River, mortality rates were very low (Stocking et al. 2006). Chinook salmon at this location did not become infected. Minimal mortality in both was likely due to low levels of parasites in this area and a predominance of Type 0 genotype of *C. shasta*. Because the parasites are endemic to the watershed, the native salmonid populations have some level of resistance to the disease.

Upper Klamath River and Connected Waterbodies

Many of the diseases and parasites described above can occur in the Upper Klamath River. *C. shasta* and *P. minibicornis* are both known to occur in the Upper Klamath Basin (NMFS 2006a), and *C. shasta* densities have been reported to be as high in the

Williamson River (Hurst et al. 2012) as in the area downstream from Iron Gate Dam (Hallett and Bartholomew 2006). However, in the section of the river upstream of J.C. Boyle Reservoir, *C. shasta* does not have the same serious effects as it does downstream from Iron Gate Dam, because of the genotype of the parasite (Type 0, II, and III) and the higher resistance of the redband trout to the disease. Historically *C. shasta* and *P. minibicornis* occurred in the Upper Klamath Basin and resident fish upstream of the dams evolved with these parasites (Hamilton et al. 2011). The current infectious zone and high parasite loads below Iron Gate Dam are the result of a synergistic effect of numerous factors (FERC 2007, Hamilton et al. 2011), including: (1) close proximity of myxospore-shedding carcasses (concentration of carcasses); (2) abundant polychaete populations that are found in atypically stable habitats; (3) suitable water temperatures (greater than 59°F) during periods when juvenile salmonids are present; and 4) low flow variability (Bartholomew and Foott 2010). This synergy would be unlikely in the Upper Klamath River (Hamilton et al. 2011), and the NMFS (2006a, USFWS/NMFS Issue 2(B)) concluded that the movement of anadromous fish upstream of Iron Gate Dam presents a relatively low risk of introducing pathogens to resident fish (e.g., redband trout, cutthroat trout).

Upper Klamath River – Hydroelectric Reach

As described above, Stocking et al. (2006) found the polychaete host for *C. shasta* and *P. minibicornis* throughout the mainstem Klamath River, including the reach from J.C. Boyle Reservoir to Iron Gate Dam (the Hydroelectric Reach), and within the Lower Klamath Project reservoirs. However, these polychaete populations are most abundant at reservoir inflow areas with densities decreasing with distance from reservoir/river interface, but not disappearing entirely (Stocking and Bartholomew 2007). In order for an area to develop as an infectious zone, several factors need to coincide, including microhabitats with low velocity, and stable flows, which are rare within this reach (Bartholomew and Foott 2010).

Middle and Lower Klamath River

In the Klamath River downstream of Iron Gate Dam, the polychaete host for *C. shasta* and *P. minibicornis* is aggregated into small, patchy populations. The reach of the Klamath River from the Shasta River to Seiad/Indian Creek is known to be a highly infectious zone with high actinospore exposure, particularly from May through August (Beeman et al. 2008, Bartholomew and Foott 2010). This portion of the river contains dense populations of polychaetes within low-velocity habitats with *Cladophora* (a filamentous green periphytic algae), sand-silt, and fine organic material in the substrate (Stocking and Bartholomew 2007). As described above, the reduced bedload mobility has increased the persistence of polychaetes under existing conditions (Som et al. 2016b). High parasite prevalence in the Lower Klamath River is considered to be a combined effect of high spore input from heavily infected, spawned adult salmon that congregate downstream from Iron Gate Dam and Iron Gate Hatchery, and the proximity to dense populations of polychaetes (Bartholomew et al. 2007). The highest rates of infection occur in the Lower Klamath River downstream from Iron Gate Dam, generally in the reach from Shasta River to Seiad (Stocking and Bartholomew 2007, Bartholomew and Foott 2010, Bartholomew et al. 2017).

Despite potential resistance to *C. shasta* and *P. minibicornis* in native populations, salmon exposed to high levels of the parasite may be more susceptible to disease—particularly juvenile salmon, and more so at higher (>59ºF [>15ºC]) water temperatures. In summarizing data collected from 2005 through 2008, Bartholomew and Foott (2010) reported that juvenile Chinook and coho salmon migrating downstream had infection rates as high as 90 percent and 50 percent, respectively. During April to August 2009 True et al. (2010) found 54 percent of juvenile Chinook salmon in the Klamath River upstream of the confluence with the Trinity River had parasitic infection from *C. shasta*, and 85 percent were infected with *P. minibicornis*. Water temperatures were not reported. During April to August 2012 True et al. (2013) found 30 percent of juvenile Chinook salmon in the Klamath River upstream of the confluence with the Trinity River had parasitic infection from *C. shasta*, and 69 percent were infected with *P. minibicornis.* True et al. (2013) reported that both *C. shasta* prevalence of infection increased in 2012 compared to 2011 (2011 results not reported). Environmentally, 2012 consisted of a relatively normal temperature profile for the Klamath River. No manipulated pulse flow from Iron Gate Dam (as in 2011) or extended period of precipitation (as in 2010) occurred. True et al. (2013) concluded that the typically warm river temperatures (59–75.2°F) observed in May–July, coupled with earlier high *C. shasta* actinospore densities (May versus June in 2011) in the infectious zone, resulted in an increase in annual infection prevalence compared to the previous monitoring year. Overall, the 2012 annual infection prevalence for juvenile Chinook salmon during outmigration was relatively moderate compared to historical levels observed for the monitoring program (2006–2011).

High disease infection rates are apparently resulting in high mortality of outmigrating smolts. Studies of outmigrating coho salmon smolts by Beeman et al. (2008) estimated that mortality rates were between 35 and 70 percent in the Klamath River near Iron Gate Dam. Their studies also suggested that higher spring discharge increased smolt survival (Beeman et al. 2008).

Between May and July 2004, the USFWS, the Yurok Tribe, and the Karuk Tribe reported high levels of mortality and disease infections among naturally-produced juvenile Chinook salmon captured in downstream migrant traps fished in the Klamath River (Nichols and Foott 2005). Visible symptoms observed included bloated abdominal cavities, pale gills, bloody vents, and pop-eye. Infected fish also exhibited lethargic behavior, poor swimming ability and increased vulnerability to handling stress. The primary cause of the disease was found to be *C. shasta*, with *P. minibicornis* observed as well. Weekly prevalence of *C. shasta* infection for all sites combined ranged from 15 to 56 percent, with the peak observed in fish captured in late May. Expanding from the trap efficiency data the authors estimated 45 percent of the population passing Big Bar was infected with *C. shasta.* Weekly prevalence of *P. minibicornis* infection for all sites combined ranged from 36 to 93 percent with the peak observed in fish captured on mid-June. Expanding from the trap efficiency data the authors estimated 94 percent of the population passing Big Bar was infected with *P. minibicornis.* The authors concluded that the high incidence of dual myxozoan infection (98 percent of *Ceratomyxa* infected fish), and associated pathology suggested that most of the *C. shasta* infected juvenile Chinook salmon would not survive. The 2004 mortality event was not quantified because of limited resources and other problems associated with sampling small fish in a large river system.

Other recent fish kills include the June 1998 and June 2000 fish kills. CDFG (2000) estimated 10,000 to 300,000 individuals, mostly young-of-year, killed in the June 2000 event. CDFG (2000) stated that, "we did not attempt to systematically or statistically quantify total [young of the year] chinook and steelhead mortality. CDFG's initial assessment of mortality in the "tens of thousands" range should be considered a very conservative minimum. I [CDFW staff] believe many more fish died than we originally observed during our surveys because of the time period involved (mid-to-late June; approximately three weeks) and the apparent high rate of scavenging (dead fish being quickly consumed and therefore unavailable for observation). It is probable that a number on an order of magnitude greater (i.e., >100,000 to 300,000) may be more realistic."

The cause of the 2000 fish kill was believed to be infection with *C. shasta* and columnaris. For comparison, in 2010 through 2012, years with lower river temperatures and conditions less conducive to disease infection, prevalence of *C. shasta* in emigrating juvenile Chinook salmon during the peak migration period was less than 30 percent (True et al. 2013).

For adult salmon, disease has been less frequent and of a different nature. Ich, a protozoan parasite that spreads horizontally from fish to fish, and columnaris have occasionally had a substantial impact, particularly when habitat conditions include exceptionally low flows, high water temperatures, and high densities of fish (such as adult Chinook salmon migrating upstream in the fall and holding at high densities in pools). For adult salmon the effects of Ich and columnaris are generally not as harmful as the observed effects of the myxozoan parasites on juveniles, although the 2002 fish kill in the Lower Klamath River provided dramatic evidence of the ability of Ich and columnaris to cause significant adult salmon mortality, with more than 33,000 adult salmon and steelhead lost during a disease outbreak (CDFG 2004). Most of the fish affected by the 2002 fish die-off were fall-run Chinook salmon in the lower 36 miles of the Klamath River (CDFG 2004). Based on a review of available literature and historical records, this was the largest known pre-spawning adult salmonid die-off recorded on the Klamath River and possibly the Pacific Coast (USFWS 2003). Subsequent reviews of the 2002 fish kill by CDFG (2004), NRC (2004), and USFWS (2003) determined several factors contributed to the epizootic outbreak of Ich and columnaris. An above-average number of Chinook salmon entered the Klamath River during this period. Flows in September 2002 were among the lowest recorded in the last 50 years (CDFG 2004), which may have caused crowding in holding areas that increased transmission of disease. Low flows can also be associated with high water temperature and lower than normal dissolved oxygen concentrations (NRC 2004). While high temperatures may have contributed to the fish kill, temperatures were not unusually high in 2002 when compared to the historical record (Belchick et al. 2004). There is little historical data on dissolved oxygen, but it has been monitoring since 2001—and dissolved oxygen concentrations were similar in 2001 and 2002. During the 2002 fish kill, dissolved oxygen concentrations did not fall below 6.0 mg/L and were eliminated as a potential cause (Belchick et al. 2004). Low river discharges were apparently unsuitable for migrating adult salmon, resulting in a large number congregating in the warm water of the Lower Klamath River (USFWS 2003). Fish passage may also have been impeded by low flows, contributing to crowding (CDFG 2004). The NRC did not rule out low flows as a contributing factor but hypothesized that high water temperatures may have also inhibited the fish from moving upstream (NRC 2004). Whether inhibited by low flows, high temperatures, or both, fish in the Lower Klamath River stopped migrating upstream, resulting in crowded, stressful conditions and possibly longer residence times in a confined reach of the river. Belchick et al. (2004) states that "consideration of all pertinent data led to the conclusion that in 2002 a relatively robust run of adult fall Chinook entered the Klamath River approximately one week earlier than usual. Environmental conditions in the River at the time of the 2002 fall-run Chinook salmon run were characterized by low flow rates and volume, and an apparent lack of migration cues to proceed upriver. The resultant migration delay, crowded conditions, and warm water temperatures provided an ideal environment for the proliferation of Ich and columnaris.

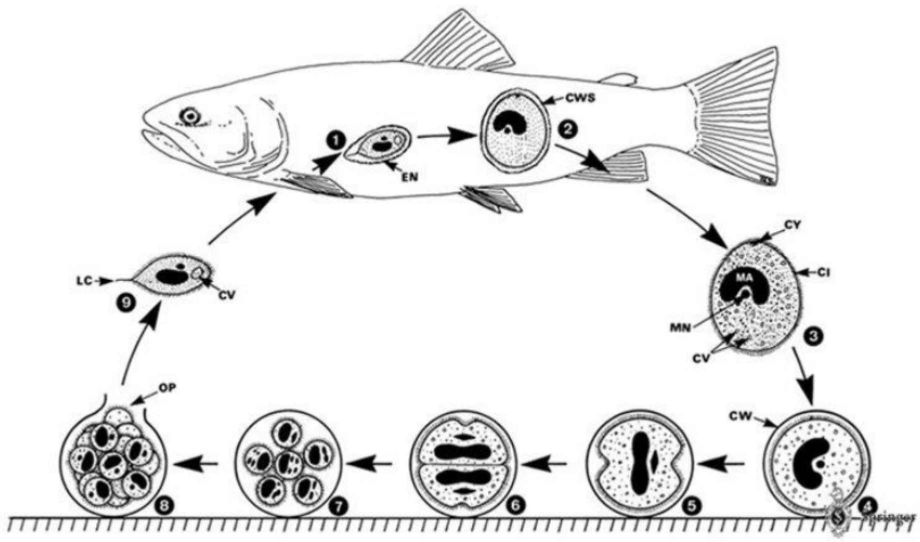

Figure 3.3-3. Lifecycle of *Ichthyophthirius multifis* (Ich). In stages 1 and 2 the adult parasite lives within the fish host; in stage 3 the adult parasite is motile outside of the host fish and attaches to a bottom substrate before dividing into an immature form; in stages 4 through 8 the immature form divides numerous times and is then released as stage 9, the infective stage of the parasite. Source: Strange 2010.

Although losses of adult salmonids can be substantial when events such as the 2002 fish die-off occur, the combination of factors that leads to adult infection by Ich and columnaris disease are not be as frequent as the annual exposure of juvenile salmon to *C. shasta* and *P. minibicornis*, as many juveniles must migrate each spring downstream past established populations of the invertebrate polychaete worm host.

FERC (2007) concluded that the Klamath Hydroelectric Project has likely contributed to conditions that foster disease and lead to salmon losses in the Middle and Lower Klamath River by (1) increasing the density of spawning adult fall-run Chinook salmon downstream from Iron Gate Dam; (2) promoting the development of attached algae beds that provide favorable habitat for the polychaete alternate host for *C. shasta* and *P. minibicornis*; and (3) contributing to water quality conditions that increase the stress level of juvenile and adult salmonids and increase their susceptibility to disease. The water quality conditions that may increase stress levels include: (1) increased water temperatures in the late summer and fall; (2) elevated ammonia concentrations and swings in dissolved oxygen and pH associated with algal blooms in project reservoirs; and (3) effects of exposure to elevated levels of microcystin produced from microcystis blooms in Klamath Hydroelectric Project reservoirs, which may also result in direct mortality. Dissolved oxygen and pH dynamics, including dissolved oxygen concentrations that do not meet the Basin Plan minimum dissolved oxygen criteria and pH concentrations that exceed the Basin Plan instantaneous maximum of 8.5 s.u., for the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary, are discussed in Section 3.2.2.5 *Dissolved Oxygen* and Section 3.2.2.6 *pH.* A discussion of fish exposure to microcystin toxin in the Hydroelectric Reach and the Klamath River downstream from Iron Gate Dam is presented below in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project – Algal Toxins*. Seasonal production of ammonia occurs in the hypoxic (dissolved oxygen less than 2 mg/L) or anoxic (no dissolved oxygen) bottom waters of Copco No. 1 and/or Iron Gate reservoirs on a seasonal basis. But, no actual ammonia toxicity events have been reported in the reservoirs or in the Middle Klamath River downstream from Iron Gate Dam, and no acute or chronic toxicity exceedances of Basin Plan criteria for ammonia have been observed in the river (Appendix C – *Sections C.3.11* and *C.3.2.1*).

In 2013, NMFS and USFWS issued a joint BiOp (NMFS and USFWS 2013) of the proposed operations of the Klamath Irrigation Project by the USBR in Klamath County in Oregon, and Siskiyou and Modoc counties in California. In this 2013 BiOp, NMFS concluded that flow variability would increase mainstem Klamath River flows when precipitation and snow melt is occurring in the Upper Klamath Basin, which would help to dilute actinospore concentrations and/or disturb polychaetes and their habitats. In addition, it found that flow variability would provide dynamic fluvial environments in the mainstem Klamath River that may impair polychaete fitness, reproductive success, or infection with *C. shasta* and *P. minibicornis*. Compared to observed conditions during the period of record, NMFS concluded that proposed operations of the Klamath Irrigation Project under the 2013 BiOp would increase the magnitude and frequency of peak flows, which would likely decrease the abundance of polychaetes in the spring and summer following a channel maintenance flow event (NMFS and USFWS 2013). The proposed operations of the Klamath Irrigation Project would increase the magnitude and frequency of channel maintenance flows between 5,000 and 10,000 cfs relative to the observed period of record (e.g., the Klamath Irrigation Project would have an estimated two-year flood frequency of 5,454 cfs whereas the observed period of record had 5,168 cfs). This conclusion is also supported by the analysis of Shea et al. (2016), who examined the flow history in the Klamath River relative to sediment mobilization. The increase in magnitude and frequency of channel maintenance flows between 5,000 and 10,000 cfs would likely decrease the abundance of polychaetes in the spring and summer following a channel maintenance flow event (NMFS and USFWS 2013, Alexander et al. 2016, Som et al. 2016b). In the 2013 BiOp, NMFS concluded that the increase in magnitude and frequency of channel maintenance flows between 5,000 and 10,000 cfs would likely decrease the actinospore concentrations relative to the observed period of record when the channel maintenance flow event occurs in the spring, particularly in May and June.

However, the first years of 2013 BiOp implementation included severe drought conditions, and although the USBR was operating the Klamath Irrigation Project in accordance with the 2013 BiOp, the infection rate for *C. shasta* in the Klamath River downstream of Iron Gate Dam greatly exceeded the incidental take maximum (U.S. District Court 2017a). As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, this led to a court-order requiring USBR to provide, as necessary, three specific flows in the Klamath River, as measured immediately downstream of Iron Gate Dam: annual winter-spring surface flushing flows, biennial winter-spring deep flushing flows, and spring-summer emergency dilution flows, if needed (U.S. District Court 2017a–c). The court-ordered flushing flows and emergency dilution flows are not part of existing conditions for the Proposed Project, because they went into effect after the Notice of Preparation was filed by the State Water Board in December 2016, and because the data evaluating the effectiveness of flows and their potential impacts is not yet robust. The flushing and emergency dilution flows are detailed in Section 4.2.1.1 *Summary of Available Hydrology Information for the No Project Alternative* as part of the No Project Alternative because they would likely only continue to apply if Iron Gate Dam remains in place, or if a nidus remains despite dam removal (these flows are also discussed in Section 4.4 *Continued Operations with Fish Passage Alternative*).

Klamath River Estuary and Pacific Ocean Nearshore Environment

While disease and parasites occur in the Klamath River Estuary and Pacific Ocean nearshore environment, these areas are not known to be important source areas for these stressors. Juvenile salmonids that are weakened by disease or parasites upstream may succumb to those diseases once they enter the estuary or ocean as a result of the additional stress created by adapting to the saline environment, but there is no evidence or observations of disease effects in this environment to date.

Fish Hatcheries

Under existing conditions, there are two fish hatcheries located along the Klamath River: Fall Creek Hatchery and Iron Gate Hatchery. Fall Creek Hatchery was built in 1919 by the California Oregon Power Company in Fall Creek, near its confluence with the Klamath River (RM 200.3), as compensation for the loss of spawning grounds that occurred with the construction of Copco No. 1 Dam. Fall Creek Hatchery facilities were last used by CDFW periodically from 1979 to 2003 to raise Chinook salmon yearlings. Fall Creek Hatchery yearlings were released into the Klamath River at Iron Gate Hatchery. Although many of the Fall Creek Hatchery facilities remain operable, the hatchery has not produced fish since 2003 when all fish production was moved to Iron Gate Hatchery.

Iron Gate Hatchery is part of the Lower Klamath Project and was originally constructed in 1962 as mitigation for blockage of fish passage caused by the construction of Iron Gate Dam. Iron Gate Hatchery facilities are located approximately 0.5 miles downstream of Iron Gate Dam, adjacent to the Bogus Creek tributary. CDFW operates Iron Gate Hatchery with the following annual production goal (CDFW 2014):

- 75,000 yearling coho salmon (age-1 releases during spring)
- 900,000 yearling fall-run Chinook salmon (age-1 releases during fall)
- 5,100,000 fall-run Chinook salmon smolts (age-0 releases during spring)
- 200,000 yearling steelhead (age-1 releases during spring)

However, the ability to meet the above production goals varies annually based on adult returns and hatchery performance. Coho salmon production has averaged 75,000 yearlings (achieving production goals) and 866 adult returns on an annual basis (CDFW 2014). Coho returns to Iron Gate Hatchery have significantly and steadily declined from a high of 2,466 adults in the 2001/2002 return year to a low of 38 adults in the 2015/2016 return year (CDFW 2016b). From 2005 through 2018 actual fall-run Chinook salmon yearling production has averaged 955,931 (exceeding production goals), and actual smolt production has averaged 4,276,728 (around a million fewer smolts than the goal on average) (K. Pomeroy, CDFW, pers. comm., 2018). The fall-run Chinook salmon hatchery spawner return goal is 8,000 fish. Total Chinook salmon returns to Iron Gate Hatchery between 1978 and 2016 ranged from 2,558 to 72,474 and averaged

16,206 fish (CDFW 2017). From 2000 to 2016, adult winter steelhead returns to Iron Gate Hatchery averaged 242, and peaked at 631 in 2001 (CDFW 2016b). Returns have been declining, and in 2016 no adult steelhead returned to the hatchery (CDFW 2016b). The low adult returns of steelhead have resulted in no production of steelhead yearlings from Iron Gate Hatchery since 2012.

It appears that progeny from Iron Gate Hatchery releases have contributed significantly to the ocean and in-river fisheries since the late 1960s (PacifiCorp 2004a). PacifiCorp (2004a) estimates that based on smolt-to-adult survival studies conducted on Iron Gate fall Chinook salmon, the Iron Gate Hatchery production contributes about 50,000 fish annually to the Chinook salmon, coho salmon, and steelhead fisheries, in addition to escapement back to the hatchery.

The net effect of hatchery releases on naturally occurring stocks is difficult to assess, with both positive and negative consequences potentially occurring due to a multitude of factors including, brood stock source, system carrying capacity, timing of release, degree of competition, and environmental selection pressures (NMFS 2017), as discussed below. Potential benefits of hatchery releases include increases in adult abundance supporting fisheries and increased marine-derived nutrient transfer to freshwater systems from returning hatchery-origin adults (NMFS 2017). Potential negative effects include genetic risks, competition and predation, hatchery facility effects on water quality, effects of weirs and other hatchery infrastructure, masking of current wild population status due to the presence of large numbers of hatchery-origin fish, incidental fishing pressure, and disease transfer from hatchery to wild fish. CDFW (2014) noted that in the Klamath River, adverse hatchery-related effects pose a very high stress to all life stages of natural salmon populations because hatchery origin adults make up greater than 30 percent of the total number of adults. Data from Ackerman et al. (2006) indicate that substantial straying of Iron Gate Hatchery fish may be occurring into important tributaries of the Middle Klamath River. Straying has the potential to reduce the reproductive success of natural salmonid populations (Mclean et al. 2003, Chilcote 2003, Araki et al. 2007) and negatively affect the diversity of the populations via outbreeding depression[85] (Reisenbichler and Rubin 1999). Returns of adult salmon to Iron Gate Hatchery, and fall-run Chinook salmon in particular, influence aquatic resources in the Middle and Lower Klamath River. Iron Gate Hatchery (RM 192.4) has a profound influence on Klamath River fall Chinook salmon in the vicinity of the hatchery. Kinziger et al. (2013) found the proportion of naturally spawning fall Chinook salmon of origin decreased with distance from the hatchery. Natural origin Chinook sampled in Bogus Creek (RM 192.6), Shasta River (RM 179.5), and the Scott River (RM 145.1) had decreasing proportions of hatchery genetics with increasing distance from the hatchery. The influence of Iron Gate Hatchery genetics on fall Chinook salmon is greatly diminished by the confluence with the Scott River.

A Hatchery Genetic Management Plan (HGMP) for the Iron Gate Hatchery (CDFW 2014) recently redefined the operation of this hatchery from a mitigation hatchery to one now operated to protect and conserve the genetic resources of the Upper Klamath population unit of the SONCC coho salmon ESU. Included in the HGMP are defined monitoring and evaluation activities to evaluate effects of the hatchery activities on the abundance, productivity, spatial structure, and diversity of the SONCC coho salmon and

[85] Outbreeding depression is the displacement of locally adapted genes in a wild population.

the magnitude or relative impact of the hatchery program on other actions that influence SONCC coho salmon.

Fall-run Chinook salmon returns to Iron Gate Hatchery and the blockage created by Iron Gate Dam, concentrate spawners and post-spawn carcass densities between Iron Gate Dam and the Shasta River confluence. As described in the *Disease and Parasites* section above, high parasite prevalence in the Lower Klamath River is considered to be a combined effect of high spore input from heavily infected, spawned adult salmon that congregate downstream from Iron Gate Dam and Iron Gate Hatchery and the proximity to dense populations of polychaetes (Bartholomew et al. 2007).

The release of Chinook salmon smolts and yearlings from Iron Gate Hatchery also affects disease interactions. The release from Iron Gate Hatchery overlaps temporally and spatially with the period of high infection potential, and studies suggest that therefore a high proportion of the Iron Gate Hatchery Chinook salmon stock can become infected with *C. shasta* and *P. minibicornis* (Som et al. 2016a). The hatchery-released juvenile fish that become infected and experience mortality lower in the Klamath River may become another source of myxospores to the Lower Klamath River.

The Chinook salmon released to the Klamath River annually also likely result in deleterious effects on natural spawning populations, including competitive pressure between hatchery-derived and natural origin fish in the limited habitat areas (e.g., thermal refugia) used by rearing juveniles in the Klamath River (NMFS 2010a). Iron Gate Hatchery releases Chinook salmon from the middle of May to the end of June, a period when discharge from Iron Gate Dam is in steep decline and water temperatures are rapidly rising, which may create competition between hatchery and natural fish (Chinook salmon, coho salmon, and steelhead) for food and limited resources, especially limited space and resources in thermal refugia (NMFS 2010a). Negative hatchery effects due to competition, leading to displacement and lower growth, are well documented (Flagg et al. 2000, McMichael et al. 1997). In the Clackamas River, Oregon, hatchery steelhead released in the upper basin resulted in an exceedance of system carrying capacity, resulting in negative outcomes for natural-origin fish (Kostow et al. 2003 and Kostow and Zhou 2006) and up to a 50 percent decline in the number of recruits per spawner and a 22 percent decline in the maximum number of natural-origin recruits. These trends appear to have reversed after releases of hatchery fish were discontinued in 2000. Such density-dependent negative effects of hatchery-released fish can extend even into the marine environment, especially during periods of poor ocean conditions (Beamish et al. 1997, Sweeting et al. 2003).

Algal Toxins

Algae produced in Upper Klamath Lake and the reservoirs in the Klamath Hydropower Reach (Copco No. 1 and Iron Gate reservoirs) may be deleterious to the health of aquatic organisms in Upper Klamath Lake and the Klamath River. Some cyanobacteria species, such as *Microcystis aeruginosa*, produce toxins that can cause irritation, sickness, or in extreme cases, death to exposed organisms (see Section 3.2.2.7 *Chlorophyll-a and Algal Toxins* and Appendix C.6). While direct links to fish health are still somewhat unclear, data collected from the Klamath Basin indicates that algal toxins bioaccumulate in tissue from fish and mussels at concentrations that may be detrimental to the affected species (Fetcho 2011), as discussed below.

While the Proposed Project would not affect the occurrence of algal toxins in Upper Klamath Lake, the following summary is provided to characterize ongoing research regarding the potential effects of microcystin toxin on native fish species in the Klamath Basin. A reconnaissance study was conducted in Upper Klamath Lake to evaluate the presence, concentration, and dynamics of microcystin exposure by Lost River sucker and shortnose sucker. The U.S. Geological Survey (USGS) collected water samples at multiple lake sites from July to October 2007 and June through September 2008 and found evidence of gastrointestinal lesions in juvenile suckers sampled from around the lake, although organ damage was absent from many fish and most of the affected fish were collected in the northern portion of the lake. The pathology of the lesions was consistent with exposure to microcystin, and evidence of a route of exposure was suggested by gut analysis showing that juvenile suckers had ingested chironomid larvae, which had in turn ingested *Aphanizomenon flos-aquae* and colonies of *Microcystis aeruginosa*. The lesions were observed when liver necrosis was either present or absent suggesting that the gastro-intestinal tract was the first point of toxin contact. The authors hypothesized that the lesions were caused by algal toxins, and that the route of exposure to toxins was an oral route through the food chain, rather than exposure to dissolved toxins at the gills (VanderKooi et al. 2010). However, there were other possible explanations for the lesions, including the potential for an undetected viral infection. Conclusive pathology experiments demonstrating that exposure of juvenile suckers to algal toxins via the described oral routes can cause the types of lesions observed have not yet been done. The pathologies and evidence therefore are consistent with the hypothesis of exposure to algal toxins but do not constitute proof of a causal mechanism. Additional work to describe the observed pathologies is ongoing.

In the Hydroelectric Reach and the Klamath River downstream from Iron Gate Dam, the occurrence of microcystin toxin in fish and mussel tissue has been reported in multiple studies with variable results depending on season, location, and fish species (Fetcho 2006; Kann 2008; CH2M Hill 2009a,b; Prendergast and Foster 2010; Kann et al. 2010 a,b; Kann et al. 2013; Fetcho 2011). During July through September 2007, 85 percent of fish and mussel tissue samples collected from the Klamath River, including samples from Iron Gate and Copco No. 1 reservoirs, exhibited microcystin bioaccumulation, with the total microcystin congeners ranging from less than detection levels to 2,803 ng/g (Kann 2008). While it is not known whether the levels of microcystin bioaccumulation measured in 2007 were harmful to fish and/or mussel populations, levels exceeded the public health guidelines defined by Ibelings and Chorus (2007), indicating that ingestion of the fish or mussels would potentially pose a health hazard to humans (Kann 2008). Within Copco No. 1 and Iron Gate reservoirs, samples of muscle and liver tissues from resident fish (e.g., yellow perch [*Perca flavescens*] and crappie [*Pomoxis nigromaculatus*]) exhibited detectable levels of two of eight microcystin congeners (i.e., chemically different forms of microcystin) in muscle and liver tissues of 36 yellow perch samples during September 2007 (Kann 2008). Unbound or "free" microcystin (the form of microcystin that could be further bioaccumulated if the fish were to be ingested by humans or other predators) was not detected in muscle tissues of yellow perch and crappie during May, June, July, September, and November 2008 (total samples = 196) (CH2M Hill 2009a). In 2010, algal toxins were found in salmonid tissues collected from the Middle Klamath River near Happy Camp (Kann et al. 2013). In contrast, data from 2008 and 2009 did not show microcystin bioaccumulation in the tissue and liver samples from fish collected from Copco No. 1 and Iron Gate reservoirs (CH2M Hill 2009, PacifiCorp 2010).

Further downstream in the Lower Klamath River, Fetcho (2006) reported that liver and muscle tissue samples from five Chinook salmon taken from the Klamath River at or near Weitchpec (near RM 43.3) in 2005 did not contain detectable levels of microcystin. However, two steelhead liver samples, collected on October 3, 2005 did contain measurable levels of microcystin at trace and 0.54 ug/g concentrations. PacifiCorp collected liver and muscle tissue samples from five Chinook salmon and three steelhead in the middle Klamath River and the Lower Klamath River downstream from the Trinity River in October 2007 and reported that no detectable levels of un-bound or “free” microcystin (the form of microcystin that could be further bioaccumulated if the fish were to be ingested by humans or other predators) were found (CH2M Hill 2009b). Because fish livers are not typically consumed, those fish exhibiting elevated microcystin levels in liver tissue may not have posed a public health concern with respect to consumption.

As noted above, while it is not known whether the levels of microcystin measured in the Lower Klamath River fish tissue samples were harmful to fish populations, the range of concentrations (up to approximately 2,800 ng/g) indicate that direct effects to fish health due to microcystin exposure such as stress and/or disease are a possibility (Kann et al. 2013). During the October period that Chinook salmon samples were collected, the 2010 longitudinal microcystin sampling in river water showed very high microcystin levels being exported from Iron Gate Reservoir and transported downstream to areas where Chinook salmon were migrating upstream. The variation in fish tissue results in Copco No. 1 and Iron Gate reservoirs and the Klamath River downstream from Iron Gate Dam across multiple studies suggests that a combination factors is likely to influence the concentration of microcystin in fish tissue, including patchy distributions of algal blooms within the Lower Klamath Project reservoirs and the downstream Klamath River, the ability of fish to move in and out of algal bloom areas where microcystin is likely most prevalent, and food web interactions that may result in differing degrees of bioaccumulation depending on the fish species.

Microcystin can also bioaccumulate in the tissue of mussels in the Lower Klamath River. Kann (2008) reported on the concentrations of eight individual microcystin congeners in freshwater mussel tissue samples obtained from the Klamath River in July and November 2007. Microcystin congeners were detected in July in composite and individual tissue samples from the Klamath River near the Klamath Highway Rest Area (at RM 178), near Seiad Valley (at RM 132.7) and at Big Bar (near RM 51). Individual mussel samples taken later in the year in November from the Klamath River near Orleans (at RM 59), near Happy Camp (at RM 108), near Seiad Valley (at RM 132.7), at the Brown Bear River Access (at RM 157.5), and near the Klamath Highway Rest Area (at RM 178) did not contain detectable levels of microcystin congeners. As noted above, 85 percent of fish and mussel tissue samples collected during July through September 2007 in the Klamath River, including Iron Gate and Copco No. 1 reservoirs, exhibited microcystin bioaccumulation (Kann 2008). While it is not known whether the levels of microcystin measured in the Lower Klamath River mussel tissue samples were harmful to mussel populations, results indicated that all of the World Health Organization (WHO) total daily intake guideline values were exceeded, including several observations of values exceeding acute total daily intake thresholds (Kann 2008). In a retrospective letter to PacifiCorp (August 6, 2008), the California OEHHA stated that they “would have recommended against consuming mussels from the affected section of the Klamath River, and yellow perch from Iron Gate and Copco No. 1 Reservoirs, because their average concentrations exceeded 26 nanograms per gram (ng/g),” which is the OEHHA upper bound of advisory tissue levels fish or shellfish consumption (for a single serving per week based on 8 ounces uncooked fish). Additional public health advisories were issued in 2009 and 2010 in Copco No. 1 and Iron Gate reservoirs, as well as downstream locations in the Klamath River (including locations on the Yurok Reservation), for microcystin levels in ambient and/or freshwater mussel tissue (Kann et al. 2010a,b, Fetcho 2011).

Aquatic Habitat and Instream Flows

Instream flows influence habitat availability for aquatic species. USBR manages Upper Klamath Lake to meet the requirements of the 2013 BiOp (NMFS and USFWS 2013)[86] and its contract requirements for USBR's Klamath Irrigation Project (USBR 2010). The Klamath Irrigation Project affects instream flows in the Klamath River downstream of Upper Klamath Lake, including the California portion of the Area of Analysis for aquatic resources. Studies to determine how fish habitat changes with flow have been conducted in portions of the Klamath River, including two reaches between J.C. Boyle Reservoir and Iron Gate Dam, for selected life stages of rainbow trout (BLM 2002) and seven locations between Iron Gate Dam and the Klamath River Estuary for selected life stages of Chinook salmon, coho salmon, and steelhead (Hardy et al. 2006).

The following sections describe the amount of flow-related aquatic species habitat in various portions of the Klamath. Where specific information is not available for a species or area, the analysis contained herein uses hydrologic changes, species habitat requirements, and comparisons with those species for which there is specific information to qualitatively assess changes in flow-related habitat. This information was used to evaluate how the Proposed Project might result in changes to the amount of flow-related habitat. It was not possible to rely on the hydrologic record of the past decade for describing the amount of habitat available under existing conditions because of management actions made over the past eight years to protect listed fish species (e.g., minimum Upper Klamath Lake elevations, minimum flows downstream from Iron Gate Dam). These changes are described in the 2013 BiOp for the Klamath Irrigation Project (NMFS and USFWS 2013), and the instream flows under existing conditions are described in Table 3.6-8 in Section 3.6.2.2 *Basin Hydrology*.

The natural hydrograph (flow regime) of a river is the characteristic pattern of flow quantity, timing, rate of change of hydrologic conditions, and variability across time scales (hours to multiple years), all without the influence of human activities (Poff et al. 1997). There are no measured river discharge data downstream from Keno Dam prior to implementation of USBR's Klamath Irrigation Project. However, modeled flows downstream of Iron Gate Dam that explicitly remove the Klamath Irrigation Project flow component offer a reasonable approximation of natural discharge downstream of Keno Dam (USBR 2005). Model results indicate that the historical, natural hydrograph for the Klamath River and its tributaries was characterized by high spring flows triggered by melting snow, typically near the end of April, followed by receding flows during summer months, and the base flow condition by September (NRC 2004). This recurring

[86] As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, following implementation of the 2013 BiOp, a court-order required USBR to implement three specific flows in the Klamath River: winter-spring surface flushing flows, winter-spring deep flushing flows, and spring-summer emergency dilution flows (U.S. District Court 2017a–c). The court-ordered flushing flows and emergency dilution flows are not part of existing conditions for the Proposed Project, because they went into effect after the Notice of Preparation was filed by the State Water Board in December 2016.

seasonal flow pattern influenced the adaptations of native aquatic organisms, as reflected in the timing of their key life history stages (NRC 2004). Given the diversity of flows inherent to the natural hydrograph, the Klamath River historically supported a range of riverine habitats and allowed the various anadromous fish species and life history strategies to evolve over time.

Upper Klamath River and Connected Waterbodies

USBR manages Upper Klamath Lake to meet the requirements of the 2013 BiOp (NMFS and USFWS 2013)[87] and its contract requirements for USBR's Klamath Irrigation Project (USBR 2010). Aquatic habitat and instream flows in the Upper Klamath River upstream of the influence of J.C. Boyle Reservoir are not thoroughly analyzed for this EIR, since aquatic species within California are not heavily influenced by these flows other than through the operation of the USBR's Klamath Irrigation Project, where the latter is controlled through the requirements of the 2013 BiOp (see below discussions).

Upper Klamath River – Hydroelectric Reach

Under its existing license, PacifiCorp operates the J.C. Boyle Powerhouse as a peaking facility, meaning that water is run through the powerhouse to generate electricity cyclically depending on water availability and power demand. Rapid changes in flow associated with hydropower peaking operations, can result in inhospitable conditions for aquatic species downstream. Peaking operations at J.C. Boyle Powerhouse result in fluctuating flows in the Hydroelectric Reach of the Upper Klamath River that vary based on power generation needs. For example, substantial changes in flow (from 350 to 3,000 cfs) can occur within the course of a single day in the 17-mile long J.C. Boyle Peaking Reach (the reach of the Klamath River between J.C. Boyle Powerhouse and Copco No. 1 Reservoir). These flow fluctuations in this reach can also result in rapid temperature changes between 5 and 59°F during the summer months (ODEQ 2010). These flow fluctuations may also result in stranding of fish and invertebrates (Dunsmoor 2006), reductions in aquatic invertebrate production (City of Klamath Falls 1986, as cited in Hamilton et al. 2011), displacement of fish, and higher energetic costs to fish to maintain their position (FERC 2007). In the trial-type hearing for the relicensing of the Klamath Hydroelectric Project (NMFS 2006a), it was found that this reach had lower macroinvertebrate drift rates than would occur without the hydroelectric project operations, suggesting a reduced food base for fish.

Fish studies in the Lower Klamath River have shown considerable biological impacts due to power peaking flows (City of Klamath Falls 1986, FERC 2007, BLM 2002, Wales and Coots 1950). From June 1948 to May 1949, Wales and Coots (1950) estimated that hydropower peaking operations resulted in the loss of over 1.8 million salmonid fingerlings downstream from Copco No. 1 and Copco No. 2 dams. Daily mean flows fell below 100 cfs in the Klamath River downstream from Copco No. 2 Dam and near Fall Creek (USGS Gage No. 11512500) on fifty occasions between water years 1931 and 1937.

[87] As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, following implementation of the 2013 BiOp a court-order required USBR to implement three specific flows in the Klamath River: winter-spring surface flushing flows, winter-spring deep flushing flows, and spring-summer emergency dilution flows (U.S. District Court 2017a–c). The court-ordered flushing flows and emergency dilution flows are not part of existing conditions for the Proposed Project, because they went into effect after the Notice of Preparation was filed by the State Water Board in December 2016.

Middle and Lower Klamath River

As described in Section 3.1.6.1 *Klamath River Flows under the Klamath Irrigation Project's 2013 BiOp*, the 2013 BiOp provides minimum flows downstream of Iron Gate Dam for the protection of coho salmon. The 2013 BiOp also includes an Environmental Water Account (EWA) with provisions for flow alterations to protect ESA-listed species, including the release of dilution/flushing water from Upper Klamath Lake to reduce juvenile coho salmon disease below Iron Gate Dam. Consultation with NMFS and USFWS has been reinitiated on the Klamath Irrigation Project in the Upper Klamath Basin (see Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*). Additional detail on flows and habitat in the Middle and Lower Klamath River are provided in Section 3.6.2.2 *Basin Hydrology*.

Klamath River Estuary and Pacific Ocean

Aquatic habitat within the Klamath River Estuary is highly influenced by freshwater inflows from upstream, and physical processes in the estuary such as sand-berm dynamics at the river mouth. The Klamath River Estuary spans approximately four to five miles upstream of the mouth. Wallace (1998) notes the formation of a sill at the river mouth in late summer or early fall causing a standing water backup up to six miles upstream. During high tides, saltwater was observed in the summer and early fall from the mouth upstream, ranging approximately 2.5 to four miles depending on the time period in which samples were taken (Wallace 1998).

Water temperatures in the Klamath River Estuary are related to temperatures and flows entering the estuary, the presence and location of a salt water wedge, and the timing and duration of the formation of a sand berm across the estuary mouth. The salt water wedge is formed when the estuary mouth is open and denser salt water from the ocean sinks below the lighter fresh river water; the resulting wedge moves up and down the estuary with the daily tides. The salt water wedge results in thermal stratification of the estuary with cooler, high salinity ocean waters remaining near the estuary bottom, and warmer, low salinity river water near the surface. Input of cool ocean water and fog along the coast minimizes extreme water temperatures much of the time (see also Section 3.2.2.2 *Water Temperature*).

Critical Habitat

The ESA requires that USFWS and NMFS designate critical habitat[88] for the listed species they manage. Critical habitat has been designated for four species within the California portion of the Area of Analysis for aquatic resources: coho salmon, shortnose suckers, Lost River suckers, and eulachon. The endangered population of Southern Resident Killer Whales that includes Klamath River salmon in its diet is also discussed here, and critical habitat for green sturgeon is discussed as well, despite the exclusion of Klamath River from the critical habitat designation.

[88] The ESA defines critical habitat as "the specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species at the time it is listed that are determined by the Secretary to be essential for the conservation of the species."

Coho Salmon

Critical habitat for the SONCC coho salmon ESU was designated on May 5, 1999 and includes the water, substrate, off-channel habitat, and adjacent riparian zones of estuarine and riverine reaches accessible to listed coho salmon between Cape Blanco, Oregon and Punta Gorda, California. Marine areas were excluded from the final critical habitat designation. "Accessible reaches" are defined as those within the historical range of the ESU that can still be occupied by any life stage of coho salmon. Specifically, in the Klamath Basin, all river reaches downstream from Iron Gate Dam on the Klamath River and Lewiston Dam on the Trinity River are designated as critical habitat (NMFS 1999b).

Features of critical habitat considered essential for the conservation of the SONCC ESU (NMFS 1997b) include (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions. Primary Constituent Elements (PCEs) for SONCC coho salmon are described in NMFS (1999b) as follows: "In addition to these factors, NMFS also focuses on the known physical and biological features (PCEs) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation."

Shortnose Sucker and Lost River Sucker

The final designation of critical habitat for shortnose and Lost River suckers was published by the USFWS on December 11, 2012 (USFWS 2012). The proposed critical habitat area is within Klamath and Lake Counties, Oregon, and Modoc County, California. Critical habitat units include: (1) approximately 146 stream miles and 117,848 acres of lakes and reservoirs for Lost River sucker; and (2) approximately 128 stream miles and 123,590 acres of lakes and reservoirs for shortnose sucker (USFWS 2012).

The 2013 Revised Recovery Plan (USFWS 2013a) identifies a recovery unit for both shortnose and Lost River within the California portion of the Area of Analysis: the reservoirs along the Klamath River downstream of Keno Dam (including Copco No. 1, Copco No. 1, and Iron Gate reservoirs), known as the Klamath River Management Unit.

When proposing critical habitat, USFWS considers the physical and biological features essential to the conservation of the species which may require special management considerations or protection. These include, but are not limited to: (1) space for individual and population growth and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing (or development) of offspring; and (5) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species. PCEs are the specific elements of physical and biological features that are essential to the conservation of the species. The PCEs identified in the critical habitat designation are as follows: (1) water in sufficient depths and quantity; (2) spawning and rearing habitat; and (3) areas that contain abundant food (USFWS 2013a). The 2013 Revised Recovery Plan (USFWS 2013a) cites predominant threats to these suckers as lack of spawning habitat, continued loss of habitat, lake elevation fluctuations that reduce access to vegetated habitat, water diversions, competition and predation by introduced species, hybridization with other sucker species, isolation of remaining habitats, and drought. Degradation of water quality resulting from timber harvest, dredging activities, removal of riparian vegetation, and livestock grazing may also cause problems for these species (USFWS 2013a).

Green Sturgeon

In 2009, NMFS designated critical habitat for the Southern DPS of green sturgeon which encompasses all coastal marine waters of the United States less than 60 fathoms deep (approximately 360 ft) from Monterey Bay, California north to Cape Flattery, Washington. The estuary portion of the Eel and Klamath/Trinity rivers was specifically excluded from the critical habitat designation (NMFS 2009b). The Northern DPS of green sturgeon, the only DPS documented to occur in the Klamath Basin, is not federally listed and therefore critical habitat has not been designated for this DPS.

Eulachon

Critical habitat for the Southern DPS eulachon in the Klamath River was designated by NMFS on October 20, 2011 (NMFS 2011). NMFS designated approximately 539 miles of riverine and estuarine habitat in California, Oregon, and Washington within the geographical area occupied by the Southern DPS of eulachon. The designation includes 16 rivers and creeks extending from and including the Mad River, California to the Elwha River, Washington. NMFS did not include any nearshore marine or offshore areas in the Eulachon critical habitat designation. NMFS did not identify any unoccupied areas as being essential to conservation and thus, did not designate any unoccupied areas as critical habitat. Tribal lands were excluded from designation after evaluating the impacts of designation and benefits of exclusion associated with Tribal land ownership and management by the Tribes. NMFS excluded from designation all lands of the Lower Elwha Tribe, Quinault Tribe, Yurok Tribe, and Resighini Rancheria. These lands were excluded because designating these Tribes' Indian lands as critical habitat would have an impact on federal policies promoting Tribal sovereignty and self-governance. In the Lower Klamath River, designated critical habitat extends from the mouth of the Klamath River upstream to Omogar Creek, a distance of 10.7 miles, excluding tribal lands. The physical or biological features essential for conservation of this species include: (1) freshwater spawning and incubation sites with water flow, quality, and temperature conditions and substrate supporting spawning and incubation; (2) freshwater and estuarine migration corridors free of obstructions with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted; and (3) nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival.

Southern Resident Killer Whale

In November 2006, NMFS designated critical habitat for Southern Resident Killer Whales (NMFS 2006c). Critical habitat includes all waters seaward from a contiguous line delimited by the 20-foot depth relative to extreme high water within three designated areas: (1) the Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. Coastal and offshore areas have not been designated as critical habitat, though they are recognized as important for the Southern Resident Killer Whales. No critical habitat for Southern Resident Killer Whales occurs within the Area of Analysis for aquatic resources. However, the PCEs for Southern Resident Killer Whales includes: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging.

Within the Area of Analysis, the PDE for "prey species" is relevant. During winter, two of the three pods of Southern Resident Killer Whales (named the K and L Pods) frequent the outer west coast of the United States as far south as California, eating Columbia/Snake River, Central Valley, Puget Sound, Fraser River, and other coastal stocks of Chinook salmon. While Southern Resident Killer Whales have been shown to consume Klamath River Chinook Salmon, the Klamath River is considered by NMFS and WDFW tenth out of the top ten priority Chinook Salmon populations for Southern Resident Killer Whales (NMFS 2018b, NMFS and WDFW 2018).

Essential Fish Habitat (EFH)

EFH is designated for commercially fished species under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (Magnuson-Stevens Act). The Magnuson-Stevens Act (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effects occur when EFH quality or quantity is reduced by a direct or indirect physical, chemical, or biological alteration of the waters or substrate, or by the loss of (or injury to) benthic organisms, prey species and their habitat, or other ecosystem components. The Magnuson-Stevens Act requires federal fishery management plans, developed by NMFS and the Regional Fishery Management Councils, to describe the habitat essential to the fish being managed and to describe threats to that habitat from both fishing and non-fishing activities. To protect EFH, federal agencies are required to consult with NMFS on activities that may adversely affect EFH.

EFH has been designated for three species of salmon, 83 groundfish species, and five pelagic species in the Area of Analysis for aquatic resources. EFH includes freshwater, estuarine and marine waters for salmon, and marine waters for coastal pelagic and groundfish species. More specific descriptions of EFH are provided below.

Chinook and Coho Salmon

Coho and Chinook salmon are managed under the Magnuson-Stevens Act and EFH is described in Amendment 14 to the Pacific Coast Salmon Fishery Management Plan (PFMC 2012). EFH for Chinook salmon is also described in the same management plan and is identical to that for coho salmon in the Klamath Basin. EFH has been designated for the mainstem Klamath River and its tributaries from its mouth to Iron Gate Dam, and upstream the Trinity River to Lewiston Dam. EFH includes the water quality and quantity necessary for successful adult migration and holding, spawning, egg-to-fry survival, fry rearing, smolt migration, and estuarine rearing of juvenile coho and Chinook salmon.

Groundfish

EFH for Pacific Coast groundfish includes all waters and substrate within areas with a depth less than or equal to 1,914 fathoms (approximately 3,500 meters) shoreward to the mean higher high-water level or the upstream extent of saltwater intrusion (defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow). The Klamath River Estuary, which extends from the river's mouth upstream to near the confluence with Ah Pah Creek, is included in the Pacific groundfish EFH (50 CFR § 660.395).

Pelagic Fish

EFH for coastal pelagic species, including finfish (northern anchovy, Pacific sardine, Pacific [chub] mackerel, and jack mackerel) and market squid, occurs from the shorelines of California, Oregon, and Washington westward to the exclusive economic zone[89] (370 km off coast) and above the thermocline where sea surface temperatures range from 50 to 78.8ºF. During colder winters, the northern extent of EFH for coastal pelagic species may be as far south as Cape Mendocino, and during warm summers it may extend into Alaska's Aleutian Islands. In each of these seasonal examples, the Klamath River Estuary and coastline would be included as EFH for these species.

3.3.3 Significance Criteria

The Proposed Project could affect aquatic resources directly or indirectly, and through a variety of mechanisms. These effects could be additive or offsetting. In determining the significance criteria, the Lower Klamath Project EIR analysis considers the total effect of the factors described above on native fish populations and their habitat in relation to the Proposed Project. These impacts could vary substantially in intensity, severity, geographic extent, population-level impact, and duration. The intensity of an impact refers to how severely it affects an organism. This severity can range from sublethal behavioral adaptations such as avoidance of a specific condition, to mortality. The geographic extent refers to how much of the species' potential habitat is affected. Population-level impact refers to the proportion of the total population that is expected to be affected. As described above in Section 3.3.2.1 Aquatic Species [coho salmon], Williams et al. (2006) described nine population units of coho salmon in the Klamath Basin to support recovery planning for the listed coho salmon SONCC ESU. Analysis of coho salmon in this EIR considers impacts and benefits for each of the nine population units in the Klamath Basin separately but makes a significance determination for all population units combined within the Klamath Basin to be consistent with the approach to assessing other aquatic species populations. Duration refers to how long the effect is anticipated to persist (hours, days, months, or years), and considers resiliency of the population to the impact (e.g., resilient populations recovery more quickly to impacts). Criteria for determining significant impacts on aquatic resources are also informed by Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.).

The Lower Klamath Project EIR considers short- and long-term effects to aquatic resources. For the Proposed Project aquatic resources impact analysis, short term is defined as less than five years following dam removal (unless otherwise indicated), which includes the periods of reservoir drawdown, dam deconstruction, and early restoration activities. A period of five years was selected as short-term, because for most aquatic resources this represents one to two generations. Long term is defined as more than five years following dam removal (unless otherwise indicated), which in most cases is more than two generations.

In the short term, effects of the Proposed Project would be significant if they:

- Substantially reduce the abundance (greater than 50 percent reduction) of a year class for aquatic species.
- Substantially decrease the quality or availability (greater than 50 percent reduction) of habitat for a native aquatic species.

[89] Exclusive economic zone is a sea zone prescribed by the United Nations Convention on the Law of the Sea over which a state has special rights regarding the exploration and use of marine resources.

- Substantially decrease the quality of designated PCEs, or availability (greater than 50 percent reduction) of designated critical habitat under the ESA, or EFH under the Magnuson-Stevens Act.

In the long term; five years after removal of all dams, effects of the Proposed Project would be significant if they:

- Substantially reduce the abundance (greater than 50 percent reduction) of an adult population or year class for aquatic species.
- Substantially decrease the quality or availability (greater than 50 percent reduction) of habitat for a native aquatic species.
- Substantially decrease the quality of designated PCEs, or availability (greater than 50 percent reduction) of designated critical habitat under the ESA, or EFH under the Magnuson-Stevens Act.

3.3.4 Impact Analysis Approach

This section provides an overview of the methods used in the evaluation of aquatic resources. This section is organized to describe methods used to evaluate effects on physical habitat (e.g., from suspended sediment, bed elevation, water quality, etc.), as well as the methods used to address effects on biological process such as fish disease and parasites. Methods are also described to specifically address aquatic habitat, critical habitat, Essential Fish Habitat (EFH), and communities that respond to environmental impacts unique from fish species such as freshwater mussels and benthic macroinvertebrates.

The following sources were assessed to determine the scope of existing local policies relevant to the Proposed Project:

- Del Norte County General Plan (Mintier & Associates et al. 2003):
  - Section 1 (Natural Resources/Conservation), Policies 1.A.1, 1.A.6, 1.A.14, 1.B.1, 1.C.1, 1.C.2, 1.C.3, 1.C.4, 1.E.2, 1.E.3, 1.E.8, 1.E.9, 1.E.11, 1.E.12, 1.E.28, and 1.E.29
- Humboldt County General Plan for Areas Outside of the Coastal Zone (Humboldt County 2017):
  - Conservation and Open Space Element, Water Resources Element, Policies BR-P4, BR-P11, BR-P12, BR-S2, BR-S4, BR-S6, WR-P5, WR-P23, WR-P39, and WR-P46
- Klamath County Comprehensive Plan (Klamath County 2010):
  - Goal 5 (Open Space, Scenic, and Historic Area and Natural Resources), Policy 16
- Siskiyou County General Plan (Siskiyou County 1980):
  - The Conservation Element (Siskiyou County 1973), Wildlife Habitat, Objectives 1, 5–8
  - The Land Use Element (Siskiyou County 1997), Policy 41.13

Most of the aforementioned policies (and objectives) are stated in generalized terms, consistent with their overall intent to protect aquatic resources, including special-status aquatic species. By focusing on the potential for impacts to specific aquatic resources within the Area of Analysis, consideration of the more general local policies listed above is addressed through the specific, individual analyses presented in Section 3.3.5 *[Aquatic Resources] Potential Impacts and Mitigation*.

The following sources were assessed to determine the scope of existing HCPs relevant to the Proposed Project and potential for overlap with the Primary Area of Analysis for Aquatic Resources: (a) PacifiCorp's Interim Operations Habitat Conservation Plan for the Klamath Hydroelectric Project (PacifiCorp 2012) and (b) Green Diamond Forest Habitat Conservation Plan (Green Diamond Resource Company 2018). These HCPs also provide generalized terms for protection of aquatic resources, including special-status aquatic species. Consideration of the HCPs is inherently addressed by the individual analyses presented in Section 3.3.5 *[Aquatic Resources] Potential Impacts and Mitigation*, which focus on the potential for impacts to specific special-status aquatic species and other aquatic resources defined in Area of Analysis.

3.3.4.1 Suspended Sediment

Suspended sediment can have a multitude of effects on aquatic species, including direct lethal impacts, or sublethal effects on behavior and physiology. The most commonly observed effects of suspended sediment on fish reported in the scientific literature include: (1) avoidance of turbid waters in homing adult anadromous salmonids, (2) avoidance or alarm reactions by juvenile salmonids, (3) displacement of juvenile salmonids, (4) reduced feeding and growth, (5) physiological stress and respiratory impairment, (6) damage to gills, (7) reduced tolerance to disease and toxicants, (8) reduced survival, and (9) direct mortality (Newcombe and Jensen 1996). Information on both concentration and duration of suspended sediment is necessary for understanding the potential severity of its effects on salmonids (Newcombe and MacDonald 1991). Herbert and Merkens (1961) stated that "there is no doubt that many species of fresh-water fish can withstand extremely high concentrations of suspended solids for short periods, but this does not mean that much lower concentrations are harmless to fish which remain in contact with them for a very long time." Effects of suspended sediment on fish may be exacerbated if pollutants or other stressors (e.g., water temperature, disease) are present as well.

As described in Appendix E of this EIR, the potential effects of suspended sediment on anadromous fish species for the Proposed Project were assessed using the SRH-1D model (Huang and Greimann 2010, as summarized in USBR 2012). The SRH-1D model provides an estimate of SSCs at different points on the Klamath River on a daily average estimate. This information is used to assess the impacts of SSCs on fish in dam removal years 1 and 2, based on the concentration and duration of exposure using an approach described by Newcombe and Jensen's (1996). Newcombe and Jensen (1996) reviewed and synthesized 80 published reports of fish responses to suspended sediment in laboratories, streams, and estuaries and established a set of equations to calculate "severity of ill effect" (SEV) indices. A suite of six equations were developed that evaluate the effects of suspended sediment (at various concentrations, durations of exposure, and particle sizes) on various taxonomic groups of fishes and life stages of species within those groups. These effects are compared to those that fish would be expected to encounter under existing conditions, as described in Section 3.6.1 *Summary of Available Hydrology Information for the Proposed Project*.

For each simulation year in the 48-year record, the duration of SSCs at a range of concentrations was calculated for each species and life-history stage (e.g., duration of SSC over 1,000 mg/L during spring-run Chinook salmon adult upstream migration). The results of modeling all potential years were summarized for each life-stage of each species assessed. Because the suspended sediment varies with hydrology, and in order to account for (and compare) the range of results and impacts that might occur under each alternative, three scenarios were selected for analysis, with the goal of defining a most likely impacts on fish scenario for the potential impacts to fish, as well as a reasonable range of potential impacts, encompassed by extremes—a "least impacts on fish scenario" and a "worst impacts on fish scenario." These represent the sediment concentrations for the median, the lowest 10 percent, and highest 10 percent of years in the available hydrological record.

- **Most-likely impacts on fish:** This scenario represents the conditions that are most likely to occur for each species and life stage—that is to say SSCs and durations with a 50 percent (median) exceedance probability for the mainstem Klamath River downstream from Iron Gate Dam. This means that there is an equal chance that the SSCs would be higher or lower than described. Exceedance probabilities were based on modeling SSCs for all water years from 1961 to 2009 under the Proposed Project.
- **Least impacts on fish:** This scenario represents the least impacts on fish from potential sediment-related impacts to a species and life stage. It uses suspended sediment concentrations and durations with a 90 percent exceedance probability. This means that under this rare, least-impacts-on-fish scenario the probability of these concentrations and durations being equal to or less than this level for each assessed species and life-stage in any one year is 10 percent, and the probability of them being exceeded is 90 percent.
- **Worst impacts on fish:** This scenario represents the worst impacts on fish of potential sediment-related impacts to the species and life stage. It uses SSCs and durations with a 10 percent exceedance probability. This means that under this rare, worst-impacts-on-fish scenario the probability of these concentrations and durations being equal to or greater than this level for each assessed species and life-stage in any one year is 10 percent, and the probability of them being less than this level is 90 percent.

The likelihood, however, that conditions under the Proposed Project would track the aforementioned scenarios precisely for each species is slim. It is more likely that different species and different life stages would be exposed to different SSCs and durations within the ranges described. For example, there are relatively few instances in modeled hydrologic record in which the median "most-likely impacts on fish" condition would occur in the same water year for all life-stages of a given species, and even fewer instances in which the median condition would occur in the same water year for all species and all life-stages. For the "least impacts on fish" and "worst impacts on fish" scenarios, the predicted SSCs and durations would be unlikely to occur (10 percent probability) during nearly all water years in the modeled hydrologic record. There are even fewer, and potentially no, instances in which the "least impacts on fish" and "worst impacts on fish" scenarios for SSCs and durations would occur in the same water year for all life-stages of a given species, and no instances in which they would occur in the same water year for all species and all life-stages.

An alternative analytic approach was considered using predicted SSCs and exposure durations associated with a particular water year type. However, it was determined that this approach had too much potential to exaggerate or understate the range of possible impacts, as it did not provide sufficient granularity in terms of the range of possible conditions experienced by particular species and/or life stages.

In assessing impacts, the above scenarios were applied for each species, and for each life stage of that species, taking into account when the species and what percent of the population is likely to be present in the Klamath River mainstem (including avoidance behavior). This EIR analysis describes the range of potential impacts to various life stages of aquatic species including relative mortality rates and sublethal impacts and were evaluated against the relevant significance criteria.

3.3.4.2 Bed Elevation and Grain Size Distribution

As described in Section 3.11 *Geology, Soils, and Mineral Resources* and Appendix F of this EIR, the analysis of potential changes in channel bed elevations and grain size distribution in response to increased bedload supply and transport also relied upon output from the SRH-1D model (Huang and Greimann 2010, USBR 2012). The changes were evaluated for a range of hydrologic conditions for short-term changes (using a 2-year timeframe) and long-term changes (including analysis of 5, 10, 25, 50 years in the future) changes using a range of flows taken from historical hydrology. For bedload dynamics two years following the changes associated with dam removal is considered sufficient for assessing short-term impacts. Long-term simulations were not conducted for the Klamath River upstream of Iron Gate Dam based on observations that the bedload sediment conditions in that reach are relatively stable and persistent, and therefore at the end of 2 years following dam removal would be representative and would persist through time, allowing for mild fluctuations as a function of hydrology rather than project effects (USBR 2012).

The effects determination used analysis of the model results and knowledge of habitat requirements of affected fish species to determine how changes in bed elevation and substrate composition would affect aquatic resources (e.g., pool habitat, spawning gravel, benthic habitat). Changes in substrate composition occurring as a result of dam removal that decreased habitat suitability were assumed to be harmful to aquatic resources and were evaluated against the relevant significance criteria.

Bedload transport in the area upstream of the influence of J.C. Boyle Reservoir are not anticipated to be affected by dam removal and are not expected to be substantially affected by the Proposed Project, are not within California, and are not evaluated further in this EIR. Link River Dam and Keno Dam would remain in place and would continue to affect hydrology and sediment transport as they do currently.

3.3.4.3 Water Quality

The analysis of potential short-term (0−5 years) and long-term (5 or more years) water quality-related effects on fish under the Proposed Project is based on the water quality impacts analysis (see Section 3.2.5 *[Water Quality] Potential Impacts and Mitigation*) for parameters to which fish are sensitive (e.g., suspended sediment concentrations [SSCs], dissolved oxygen, pH), as well as effects determinations for state and approved tribal designated beneficial uses that are directly related to fish.

This EIR evaluates the potential effects of sediment-associated toxins on fish under the Proposed Project by using the results of multiple screening-level comparisons of sediment contaminant levels identified in reservoir sediments that are currently trapped behind the dams. These water quality methods are described in greater detail in Section 3.2.4.7 *Inorganic and Organic Contaminants*. Alterations in water quality occurring as a result of dam removal under the Proposed Project that are projected to decrease (or increase) habitat suitability or to result in direct effects on aquatic species are evaluated against the relevant significance criteria.

3.3.4.4 Water Temperature

The EIR uses water temperature output from three quantitative models (see Section 3.2.4.1 *[Impact Analysis Approach] Water Temperature* and Appendix D for details regarding the water temperature models) to evaluate the potential impacts related to changes in water temperature on species within each study reach of the Area of Analysis. Water temperature modeling results were compared to the thermal tolerances of focal species and associated life stages to determine relative suitability for these species under the Proposed Project. Changes in water temperature occurring as a result of dam removal that were predicted to decrease (or increase) habitat suitability or result in direct effects on aquatic species were evaluated against the relevant significance criteria.

3.3.4.5 Fish Disease and Parasites

Fish diseases, specifically *C. shasta* and *P. minibicornis*, have periodically contributed to substantial mortality for Klamath River salmonids (discussed in detail in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*). Environmental variables such as temperature, flow, sediment (bedload composition and stability), plankton (high quality food abundance), and nutrients are thought to affect the abundance of *P. minibicornis* and *C. shasta* via habitat for the intermediate invertebrate host (annelid polychaete worm *Manayunkia speciose*); therefore, differences in river habitat conditions that are predicted under the Proposed Project are anticipated to affect the abundance of these parasites and their infection rates in Klamath Basin salmonids. Bartholomew and Foott (2010) prepared a compilation of available information regarding Myxozoan disease relative to the Klamath River and, in their analysis they considered several factors that could, if co-occurring, lead to high disease infection rates of fish, including:

- Physical habitat components that support the invertebrate host species (pools, eddies, sediment, mats of filamentous green algae [periphyton])
- Microhabitats with low velocity and unnaturally stable flows
- Close proximity to salmon spawning areas
- Water temperatures higher than 59°F

Ich and columnaris may also occasionally have a substantial impact on aquatic resource (e.g., 2002 fish kill, CDFW 2004). Factors that could, if co-occurring, lead to high Ich and columnaris infection rates of fish, including:

- Exceptionally low flows
- Water temperatures higher than 59°F

- High densities of fish (such as adult Chinook salmon migrating upstream in the fall and holding at high densities in pools).

The potential effects of the Proposed Project on fish disease were evaluated based on the predicted effect of dam removal on the environmental factors that drive disease infection rates. The predicted outcome for increased or decreased fish disease and mortality were evaluated against the relevant significance criteria.

3.3.4.6 Aquatic Habitat

To assess the effect of the Proposed Project on available aquatic habitat, changes to habitat area were assessed for each life stage qualitatively, using available data on suitable habitat area upstream of existing barriers predicted to be affected by the alternatives, habitat requirements, and expected changes in instream flows under the alternatives. Qualitative analyses in this EIR rely on data evaluated for other affected factors (water temperature and fish passage) and expected changes in geomorphic processes, such as short- and long-term changes in sediment transport and deposition, to determine increases or decreases in habitat relative to existing conditions for the different species and life stages in the various reaches. Changes in aquatic habitat quality and quantity occurring as a result of dam removal were evaluated against the relevant significance criteria.

3.3.4.7 Critical Habitat

NMFS has designated critical habitat for coho salmon, Southern Resident Killer Whales, and eulachon, and USFWS has designated critical habitat for shortnose and Lost River suckers. Within critical habitat, NMFS and USFWS has determined that the PCEs essential for the conservation of these species are those sites and habitat components that support one or more life stage. Critical habitat for Southern Resident Killer Whales does not extend into coastal or offshore habitats (NMFS 2006c). The effects of each alternative on critical habitat were based on evaluation of the physical, chemical and biological changes that were expected to occur to designated critical habitat within the Area of Analysis for aquatic resources and how those changes would affect the PCEs (for those species for which PCEs have been designated) for that critical habitat in the short- and long-term; and were evaluated against the relevant significance criteria for critical habitat.

3.3.4.8 Essential Fish Habitat

The effects of the Proposed Project and each alternative on EFH were based on evaluation of the physical, chemical and biological changes that were expected to occur to EFH within the Area of Analysis for aquatic resources and whether those changes would have short- and long-term negative or beneficial effects on this habitat in terms of its quantity and quality; and were evaluated against the relevant significance criteria for EFH.

3.3.4.9 Freshwater Mollusks

Increased levels of fine sediment, both suspended in the water column and along the channel bed, can inhibit the growth, production, and abundance of freshwater mollusks (especially mussels and clams). Therefore, the analysis of impacts associated with the

Proposed Project focuses on short- and long-term changes in SSCs (Aldridge et al. 1987, as cited in Henley et al. 2000) and stream substrate texture (Howard and Cuffey 2003, Vannote and Minshall 1982). The evaluation focuses on freshwater mussels because of their similar distribution to other freshwater mollusks, similar habitat requirements, their longer life-span, and lack of information regarding the effects of sediment on clams and other mollusks. Suspended sediment impacts on freshwater mussel species were evaluated using output from the SRH-1D (Huang and Greimann 2010) sediment transport model as discussed above for suspended and bedload sediment.

Aldridge et al. (1987, as cited in Henley et al. 2000) showed that exposure to SSCs of 600-750 mg/L led to reduced survival of freshwater mussels found in the eastern United States. No duration of exposure was cited in the study. No comparable data are available for the species in the Klamath River. Using 600 mg/L as the minimum SSCs that would be detrimental to freshwater mussels, alternatives were compared to each other by determining the number of days during which this criterion threshold would be exceeded.

Analysis of impacts due to changes in bedload transport on the four species of freshwater mussels considered modeled changes in median sediment size, under the Proposed Project. Changes in habitat quality and quantity predicted for mussels and clams, as well as predictions of potential direct impacts (mortality), were evaluated against the relevant significance criteria.

3.3.4.10 Benthic Macroinvertebrates

Suspended sediment and turbidity can cause stress to benthic macroinvertebrate (BMI) populations through impaired respiration; reduced feeding, growth, and reproductive abilities; and reduced primary production (Lemly 1982, Vuori and Joensuu 1996). Therefore, potential short-term and long-term effects of the Proposed Project on BMIs were evaluated for both short- and long-term changes in SSCs and bedload sediment. Suspended sediment impacts on BMIs were evaluated using output from the SRH-1D (Huang and Greimann 2010) sediment transport model as discussed above for suspended and bedload sediment.

Changes in substrate size or embeddedness may influence the distribution, abundance, and community structure of BMIs (Bjornn et al. 1977, McClelland and Brusven 1980, Ryan 1991). Bed texture changes that would occur under the Proposed Project were qualitatively evaluated to determine whether changes in substrate composition would likely decrease macroinvertebrate abundance or alter the community composition to the extent that these communities could no longer support sufficient fish populations in the Area of Analysis for aquatic resources.

The effects on BMIs were based on water quality determinations (e.g., dissolved oxygen, toxicity) (see Section 3.2 *Water Quality*) and evaluated in the same manner as described for fish and mollusks. Changes in habitat quality and quantity predicted for BMIs, as well as predictions of potential direct impacts (mortality), were evaluated against the relevant significance criteria.

3.3.5 Potential Impacts and Mitigation

The Proposed Project would affect the physical, chemical, and biological components of habitat within portions of the Klamath Basin. These effects would result from changes in suspended sediment, bedload sediment, water quality, water temperature, disease and parasites, habitat availability, and flow-related habitat. As described in the following sections, these changes would act in both beneficial and harmful ways on species, critical habitat, and EFH. Some of the changes would be short-term, and others permanent. This section first describes the Proposed Project's anticipated effects on these key ecological attributes that could affect aquatic resources. As was the case under the descriptions of key attributes under the Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*, this section includes, as relevant, specific analysis relevant to specific segments of the Area of Analysis. More detailed technical descriptions of the Proposed Project's projected effects on suspended sediment, bedload sediment, and potential impacts on aquatic species, can be found in Appendices E and F of this EIR. Based on the analysis of effects to key ecological attributes, this section then goes on to discuss specific impacts and evaluate them under the significance criteria, discuss mitigation measures, and determine impact significance.

3.3.5.1 Suspended Sediment

Suspended sediment effects under the Proposed Project are summarized here, and are described in more detail in Potential Impact 3.2-3 *Short-term increases in suspended sediments due to release of sediments currently trapped behind the Lower Klamath Project dams*, and Appendix E. As discussed below, suspended sediment analysis interprets model output from USBR (2012) with modifications in light of proposed changes to the drawdown rate that would increase the peak sediment concentrations and decrease the duration of such elevated concentrations.

<u>Hydroelectric Reach</u>

Sediment transport modeling of the impacts of dam removal indicate high short-term SSCs in the Hydroelectric Reach under the Proposed Project (USBR 2012, 2016). Modeled SSCs downstream of J.C. Boyle Reservoir would be high (>1,000 mg/L) in the short term, but concentrations would be considerably less than those anticipated to occur downstream from Copco No. 1 and Iron Gate reservoirs due to the relatively small volume of the sediment deposits behind J.C. Boyle Dam (eight percent of total volume for the Lower Klamath Project). The suspended sediments released from J.C. Boyle would quickly move into the California portion of the Hydroelectric Reach. Elevated suspended sediments in the Hydroelectric Reach during reservoir drawdown would be a significant and unavoidable impact (see Potential Impact 3.2-3). Predicted SSCs decrease to less than 100 mg/L within five to seven months following drawdown, and concentrations further decrease to less than 10 mg/L within six to 10 months following drawdown of J.C. Boyle Reservoir.

Modeling of sediment concentrations downstream of Copco No. 1 Reservoir during drawdown also indicates short-term sediment concentrations would be high (>5,000 mg/L) in the California portion of the Hydroelectric Reach due to dam removal. Predicted spikes in SSC after one to two months of reservoir drawdown correspond to increases in Klamath River flow through the Hydroelectric Reach due to spring storm events, and within six to 10 months following drawdown would decrease to levels that exist under existing conditions (e.g., <100 mg/L).

Middle and Lower Klamath River

Under the Proposed Project, full removal of the Lower Klamath Project reservoirs would result in the release of 5.3 to 8.6 million cubic yards (1.2 to 2.3 million tons) of sediment stored in the reservoirs into the Klamath River downstream from Iron Gate Dam (USBR 2012), resulting in higher SSCs than would normally occur under existing conditions. Reservoir drawdown (lowering of reservoir water surface elevation) is expected to commence in dam removal year 1, and to be completed in dam removal year 2 (Section 2.7.2 *Reservoir Drawdown*). Based on the suspended sediment modeling (USBR 2012), SSCs are expected to exceed 1,000 mg/L directly downstream of Iron Gate Dam for around two to three continuous months, with the potential for peak concentrations exceeding 5,000 mg/L for hours or days, depending on hydrologic conditions during dam removal. Model results indicate SSC would be highest during the period of greatest reservoir drawdown (January through mid-March of dam removal year 2), as erodible material behind the dams is mobilized downstream (see Potential Impact 3.2-3). During normal to dry water years, modeled SSCs would begin to decline in late March of dam removal year 2 and would continue declining through early summer of dam removal year 2 (USBR 2012). If it is a wet year, it may take longer to drain the reservoirs and high (>250 mg/L) concentrations may extend until June. Differences between the modeled conditions and the Proposed Project would be expected to increase the magnitude of peak SSCs but decrease the duration of elevated SSCs compared to modeled SSCs (see Potential Impact 3.2-3). The Proposed Project incorporates a higher maximum drawdown rate (i.e., 5 feet per day compared to 3 feet per day) and sediment jetting during drawdown that would transport more erodible material, so less erodible material would be available to be transported after drawdown concludes and SSCs potentially would decline more rapidly after drawdown. However, modeled SSCs are used as a conservative estimate of the duration of elevated SSCs. The SSCs would be near background conditions for all water year types within the first year following removal. Tributaries between the Hydroelectric Reach and the estuary contribute a significant amount of both water and suspended sediments to the Klamath River mainstem. This causes the influence of Lower Klamath Project reservoir sediment releases to decline in the downstream direction. At Iron Gate Dam (Figure 3.2-11 through 3.2-13), where SSCs are artificially low under existing conditions (because of sediment trapping by the dam) SSCs would remain elevated above existing conditions throughout the first 2 years, and in the long term would decrease (as reservoir deposited sediments evacuated) to return to levels slightly higher than the current levels as sediment naturally transports downstream. At Orleans, where SSCs under existing conditions are higher because of inputs of tributaries, under a most-likely impact on fish scenario, the effects of the Proposed Project would be similar to existing conditions by late April when SSCs from the Proposed Project are predicted to decrease. Under a worst impacts on fish scenario SSCs are projected to remain somewhat elevated above existing conditions until October during the year of dam removal. By Klamath Station (downstream of confluence with Trinity River) SSCs under existing conditions are higher than at the upstream sites as a result of sediment input from tributaries. As a result, SSCs from the Proposed Project and those under existing conditions would be similar under all scenarios by late spring of the year of dam removal.

Klamath River Estuary

As a result of the influence of Lower Klamath Project reservoir sediment releases declining in a downstream direction, the difference between SSCs from the Proposed Project and those under existing conditions would be relatively minor in the Klamath

River Estuary (USBR 2012). The SSCs and durations under the most-likely impacts on fish scenario would be similar to those that occur under existing extreme conditions (10 percent exceedance) and resemble those that would be expected to occur about one in 10 years on average under existing conditions. Under the worst impacts on fish simulation, SSCs and durations would be slightly higher (around 10 percent) than those for the existing extreme conditions during the winter of dam removal.

Pacific Ocean Nearshore Environment

In contrast to the Lower Klamath River, modeled short-term SSCs following dam removal are not available for the nearshore marine environment adjacent to the Klamath River. Substantial dilution of the mainstem river SSCs is expected to occur in the nearshore under the Proposed Project. Based on data from 110 coastal watersheds in California, where nearshore SSCs were measured at greater than 100 mg/L during the El Niño winter of 1998 (Mertes and Warrick 2001), peak SSCs leaving the Klamath River Estuary from upstream sources including the Proposed Project may be diluted by 1 to 2 orders of magnitude; for example from greater than 1,000 mg/L to greater than 10–100 mg/L. Therefore, the SSCs in the nearshore ocean would be expected to be similar to what would occur during existing extreme conditions.

As described in detail in Potential Impact 3.2-3, during several large flood events on the geographically proximal Eel River in the winter of 1997 and 1998, Geyer et al. (2000) found that: 1) flood conditions were usually accompanied by strong winds from the southern quadrant; 2) the structure of the river plume was strongly influenced by the wind-forcing conditions; and 3) during periods of strong southerly (i.e., downwelling favorable) winds, the plume was confined inside the 164-ft isobath (i.e., sea floor contour at around 164-ft below the water surface), within about 4 miles of shore. Based upon Eel River plume studies and current knowledge of northern California oceanographic patterns, the fine sediment discharged to the Pacific Ocean nearshore environment under the Proposed Project would likely be delivered to the ocean in a buoyant river plume that hugs the shoreline as it is transported northward. However, since the flushing of sediments from behind the dams would occur over a number of weeks to months (and perhaps to some degree over 1–2 years), the plume carrying reservoir sediments would likely be influenced by a range of meteorological and ocean conditions (e.g., storm and non-storm periods, differing storm directions). Therefore, some of the time the plume would likely be constrained to shallower nearshore waters, while at other times it would likely extend farther offshore and spread more widely, including within some or all of the Klamath River Management Zone. While elevated SSCs (i.e., 10–100 mg/L) created in the nearshore plume would affect physical water quality characteristics specified in the Ocean Plan (i.e., visible floating particulates, natural light attenuation, the deposition rate of inert solids), the effects are likely to be within the range of concentrations and duration caused by historical storm events.

River plumes and the associated habitat conditions they create are considered to be areas of high productivity for marine organisms (Grimes and Funucane 1991, Morgan et al. 2005), and create abrupt changes in marine water quality conditions (e.g., water temperature, salinity, sediment) that support salmonids (Schabetsberger et al. 2003, De Robertis et al. 2005). Due to the relatively small magnitude of SSCs released to the nearshore environment, the anticipated rapid dilution of the sediment plume as it expands in the ocean, and the relatively low rate of deposition of sediments to the Pacific Ocean nearshore environment bottom substrates, any SSCs elevations associated with the Proposed Project are not anticipated to have effects on species distinguishable from existing conditions.

3.3.5.2 Bed Elevation and Grain Size Distribution

The potential effects of increased bedload supply and transport on channel bed elevations and grain size under the Proposed Project are described in Appendix F and summarized in Section 3.11.5.4 *Channel Morphology and Substrate*. As a result of the Proposed Project, the bedload transport processes that salmon evolved with and depend upon to provide substrate suitable for spawning and early rearing in streams and rivers (that are currently interrupted by the Lower Klamath Project dams) would be restored to a more natural condition.

3.3.5.3 Water Quality

Upper Klamath River and Connected Waterbodies

Dam removal activities under the Proposed Project would not affect water quality in the following areas of the Upper Klamath Basin: Wood, Williamson, and Sprague Rivers, Upper Klamath Lake, and Link River to the upstream end of J.C. Boyle Reservoir.

However, existing water quality problems have the potential to negatively impact anadromous salmonids' ability to access waters upstream of the Hydroelectric Reach under the Proposed Project. Water quality problems (e.g., excessive water temperatures and low dissolved oxygen) in the Keno Impoundment/Lake Ewauna during late spring, summer, and early autumn, led NMFS and USFWS to prescribe interim trap-and-haul measures in their Section 18 Prescriptions for the Klamath Hydroelectric Project (DOI 2006) to transport primarily adult fall-run Chinook salmon past Keno Impoundment/Lake Ewauna during periods when conditions would be harmful to salmonids. This would entail seasonal, upstream trap and haul for primarily fall-run adult Chinook salmon around the Keno Impoundment/Lake Ewauna when dissolved oxygen and water temperatures do not meet the applicable criteria (i.e., typically during July through October), since migrating salmonids would have access to this reach of the Klamath River. In the downstream Keno Impoundment/Lake Ewauna, dissolved oxygen reaches very low levels (less than 1 to 2 mg/L) during July through October of most years as algae transported from Upper Klamath Lake settle out of the water and decay (see Figure 3.4-9 in Appendix C.4.1.1). During most years, the Keno Impoundment/Lake Ewauna reach of the Klamath River (Link River Dam to Keno Dam) maintains dissolved oxygen concentrations greater than 6 mg/L from mid-November through mid-June (Appendix C.4.1.1). These dissolved oxygen concentrations are generally acceptable for migrating adult anadromous salmonids (USEPA 1986) for these months and are typically above the ODEQ water quality objective for cool water aquatic life (6.5 mg/L minimum, see Section 3.2.2.5 *Dissolved Oxygen*). Under KHSA Section 7.5.1, the Secretary of the Interior shall initiate a study to evaluate disposition of Keno Dam, including fish passage. Eventual attainment of the Oregon (ODEQ 2002, 2010) and California (USEPA 2008) TMDLs for dissolved oxygen (and other water quality parameters that would improve dissolved oxygen [i.e., pH, chlorophyll-*a*]) would improve water quality in the Keno Impoundment/Lake Ewauna and potentially eliminate water quality as a potential limitation to fall Chinook migration, and therefore the need for trap and haul activities around these waterbodies. However, full TMDL compliance does not reflect the existing condition and it would be speculative at this point to identify either the mechanisms necessary to implement the TMDLs or the timing required to achieve full compliance.

Upper Klamath River - Hydroelectric Reach

As described in Potential Impact 3.2-9, dam removal would result in short-term increases in oxygen demand and corresponding reductions in dissolved oxygen within the Hydroelectric Reach, with anoxia (0 mg/L) possible during reservoir drawdown periods when suspended sediment concentrations are at their peak (January to March of dam removal year 2). This would be a significant and unavoidable impact. In the long term, the Proposed Project would result in somewhat reduced daily fluctuations in dissolved oxygen in the Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir, which may be due to elimination of hydropower peaking operations (Potential Impact 3.2-10). Dissolved oxygen in the free-flowing river reaches replacing the reservoirs would no longer experience the extreme conditions of super-saturation (i.e., greater than 100 percent saturation) in surface waters and hypolimnetic oxygen depletion in bottom waters of Copco No. 1 and Iron Gate reservoirs during the April/May through October/November period, which would be generally beneficial.

Under the Proposed Project, pH in the Hydroelectric Reach would no longer experience high levels (pH greater than 9) during seasonal algal blooms in the surface waters of Copco No. 1 and Iron Gate reservoirs (Potential Impact 3.2-11). pH in the free-flowing reaches of the river replacing the reservoirs would not exhibit such high levels, instead possessing a more typical riverine signal. While daily fluctuations in pH could occur due to periphyton growth in the river reaches previously occupied by Lower Klamath Project reservoirs, the increases are expected to consistently meet water quality objectives to support beneficial uses and would therefore be beneficial.

Middle and Lower Klamath River

Sediment release associated with dam removal under the Proposed Project would cause short-term increases in oxygen demand and corresponding reductions in dissolved oxygen (Potential Impact 3.2-9) in the Middle Klamath River. During reservoir drawdown periods when suspended sediment concentrations are at their peak (January to March of dam removal year 2), dissolved oxygen concentrations would drop to very low levels (potentially 0 mg/L) immediately downstream from Iron Gate Dam and, depending on background conditions at the time of reservoir drawdown, would remain below 5 mg/L until approximately the confluence with the Shasta River (RM 179.5), or as far downstream as RM 121.7 (approximately 10 miles downstream of Seiad Valley [RM 132]). Recovery to the North Coast Basin Plan water quality objective of 90 percent saturation (i.e., 10–11 mg/L) is anticipated to occur in the reach from Seiad Valley to the mainstem confluence with Salmon River (RM 66), and would therefore not affect dissolved oxygen in the Lower Klamath River, the Klamath River Estuary or the Pacific Ocean nearshore environment.

Removal of the Lower Klamath Project dams under the Proposed Project and conversion of the reservoir reaches to a free-flowing river would result in long-term seasonal (July through November) increases in dissolved oxygen for the reach immediately downstream from Iron Gate Dam (Potential Impact 3.2-10), which would be beneficial relative to existing conditions. Increased diel (i.e., 24-hour period) variability in dissolved oxygen would also occur in the reach immediately downstream of Iron Gate Dam to approximately Seiad Valley (RM 132.7), with modeled concentrations consistently in compliance with the Basin Plan water quality objective of 85 percent saturation. Long-term effects of dam removal on dissolved oxygen would diminish with distance downstream from Iron Gate Dam, with similar or the same predicted dissolved oxygen concentrations and similar magnitude and duration of diel fluctuations by Seiad Valley (RM 132.7) and no differences by the confluence with the Trinity River (RM 43.3).

Under the Proposed Project, pH in the Middle Klamath River downstream from Iron Gate Dam (particularly upstream of the Shasta River confluence [RM 179.5]) during late-summer and early-fall months (August–September) would experience generally high pH (8 to slightly greater than 9 s.u.) and large daily variations in pH during periods of high photosynthesis (Potential Impact 3.2-11). The magnitude of photosynthesis and community respiration from periphyton growth in the Middle Klamath River under the Proposed Project is not entirely certain, but differences in pH between the Klamath TMDL model "TMDL dams-in" (T4BSRN) and "TMDL dams-out" (TOD2RN) scenarios decrease in magnitude with distance downstream from Iron Gate Dam, and are considerably dampened by the Scott River confluence (RM 145.1).

3.3.5.4 Water Temperature

Upper Klamath River – Hydroelectric Reach

Under the Proposed Project, the Hydroelectric Reach would no longer be dominated by hydropower peaking events and flows would more closely mimic the natural hydrograph. Elimination of peaking operations at J.C. Boyle Powerhouse would result in water temperatures in the J.C. Boyle Peaking Reach at the Oregon-California state line (RM 214.1) that exhibit slightly lower daily maximum values (0.0–3.6°F) and lower diel (i.e., 24-hour period) water temperature variation during June through September as compared to a "dams-in" condition, with temperatures moving toward the natural thermal regime (see also Potential Impact 3.2-1).

In the absence of the Lower Klamath Project reservoirs, hydraulic residence time in this reach would likely decrease from several weeks to less than a day, and water temperature suitability for native aquatic species would be improved (Hamilton et al. 2011). Removal of the Lower Klamath Project reservoirs would result in a slight increase in flow as the evaporative losses would be reduced. Evaporation from the surface of the reservoirs is currently about 11,000 acre-feet/year and after dam removal the evapotranspiration in the same reaches is expected to be approximately 4,800 acre-feet/year, potentially resulting in a gain in flow to the Klamath River of up to approximately 6,200 acre-feet/year (USBR 2011). Whether this increase would contribute to increased instream flows or be used upstream to supplement irrigation deliveries is uncertain, so this EIR discloses the potential increase but does not rely on it for conclusions (see also Section 3.8.4 *[Water Supply/Water Rights] Impacts Analysis Approach*). The reservoir drawdowns would allow tributaries and springs such as Fall, Shovel, and Spencer creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). To assess whether hot springs near the Shovel Creek confluence with the Klamath River heat the water to an extent that it would be necessary to assess impacts to fisheries, water temperatures were recorded in Shovel Creek on November 1, 2017, and were 3.3°F cooler than in the mainstem Klamath River (46°F in Shovel Creek), and 0.6°F cooler on December 5, 2017 (39.9°F in Shovel Creek) (KRRC 2018). On the same dates, water temperature data was collected both upstream and downstream of the Klamath Hot Springs, located in the

Klamath River downstream of the confluence with Shovel Creek. Water temperatures on November 1, 2017 were 1.4°F warmer downstream of the hot springs, and 0.2°F cooler on December 5, 2017; no evidence of appreciable warming as a result of the hot springs was observed on these dates (KRRC 2018).

Temperature conditions would also improve farther downstream in the Hydroelectric Reach. From Copco No. 1 Reservoir to Iron Gate Reservoir, removal of the Lower Klamath Project reservoirs would result in a decrease in water temperatures during the fall and spring (discussed in detail in Potential Impact 3.2-1). The effects of changes in temperature regimes within this reach would be similar to those discussed in detail below for the Middle and Lower Klamath River.

Removing the Lower Klamath Project dams would allow access to tributaries upstream of Iron Gate Dam that could provide additional habitat for anadromous fish (DOI 2007), including groundwater-fed areas resistant to water temperature increases caused by changes in climate (Hamilton et al. 2011). In addition, the mainstem downstream from Iron Gate Dam would reflect natural temperature regimes (Hamilton et al. 2011). The conversion of an additional 22 miles of reservoir habitat to riverine and riparian habitat (Cunanan 2009) would improve water quality by restoring the nutrient cycling and aeration processes provided by a natural channel. These improvements resulting from implementing the Proposed Project would likely moderate the anticipated stream temperature increases resulting from climate change (see Potential Impact 3.2-1).

Middle and Lower Klamath River

The thermal lag caused by water storage in Lower Klamath Project reservoirs and the associated increased thermal mass would be eliminated in the Lower Klamath River under the Proposed Project (see Potential Impact 3.2-1). This elimination would cause water temperatures to become more in sync with historical migration and spawning periods for the Klamath River, warming earlier in the spring, and cooling earlier in the fall compared to existing conditions (Hamilton et al. 2011).

Under the Proposed Project, warmer springtime temperatures would result in fry emerging earlier (Sykes et al. 2009), encountering favorable temperatures for growth sooner than under existing conditions (Figure 3.3-2), which could support higher growth rates and encourage earlier outmigration downstream similar to what likely occurred under historical conditions, and reducing stress and disease (Bartholow et al. 2005, FERC 2007). A predicted earlier outmigration in response to elevated water temperatures in the spring is also supported by a vast body of literature relating to increased growth rates and thermal response of outmigrating salmonids (as reviewed by Hoar 1988). In addition, fall-run Chinook salmon spawning in the mainstem during fall would no longer be delayed (reducing pre-spawn mortality) (Figure 3.3-3), and adult migration would occur in more favorable water temperatures than under existing conditions (Figure 3.3-3). Overall, these changes would result in water temperatures more favorable for salmonids in the mainstem Klamath River downstream from Iron Gate Dam.

The elimination of the thermal lag would also cause water temperatures to have natural diel variations (Figure 3.3-3) similar to what would have occurred historically in the Klamath River. This effect would be most pronounced downstream from Iron Gate Dam, would decline with distance downstream, and by the confluence of the Salmon River (RM 66) would exhibit no difference between the Proposed Project and existing conditions. The highest temperatures experienced by aquatic species would increase during summer (June through August), which could increase physiological stress, reduce growth rates, and increase susceptibility to disease during summer (Figure 3.3-3).

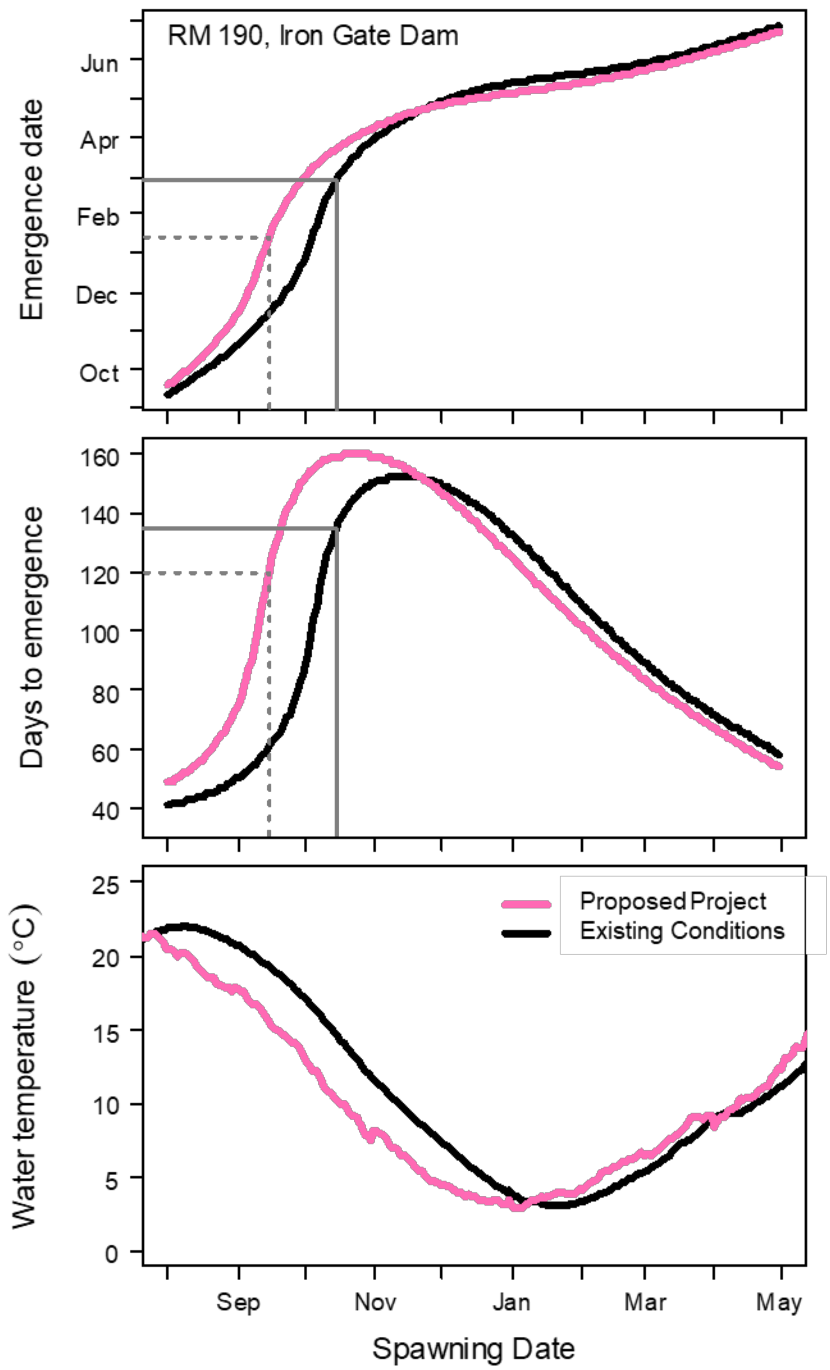

Figure 3.3-4. Perry et al. (2011) Modeled Time Series of Average Daily Mean Water Temperature (lower panel) Predicted at Iron Gate Dam (RM 193.1) Under the Proposed Project and Existing Conditions. Days to emergence (middle panel) and date of emergence (upper panel) for fall-run Chinook salmon was estimated as a function of spawning date assuming that emergence would occur at 889 degree days (accumulated heat related to development) after spawning (Perry et al. 2011).

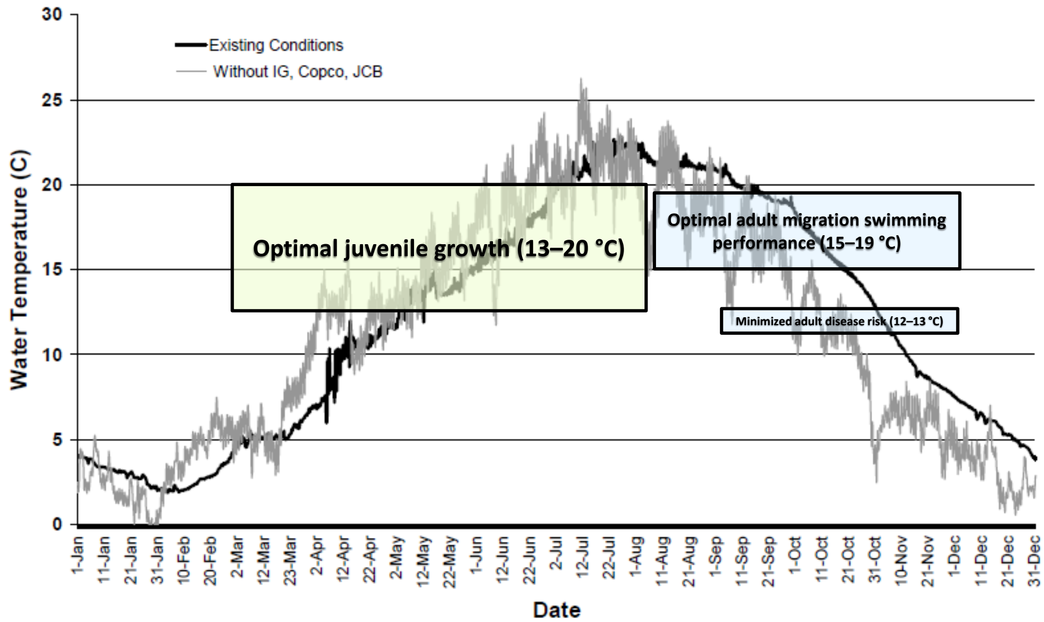

Figure 3.3-5. PacifiCorp (2005) Simulated hourly water temperatures below Iron Gate Dam based on a dry water year (WY 2002) for existing conditions compared to the Proposed Project (without Lower Klamath Project dams), and USEPA (2003) water temperature criteria for salmonid growth and migration.

However, the FERC EIS (2007) states that the increase in average and maximum daily temperatures may be compensated for by lower temperatures at night, which NRC (2004) concludes may allow rearing fish to move out of temperature refugia to forage at night, allowing growth to occur even when ambient day time temperatures are above optimal. Foott et al. (2012) observed positive growth and no apparent effect of elevated temperature on immune function or fitness in Klamath River juvenile Chinook salmon held over a 23-day period under conditions in the laboratory that simulated fluctuating water temperature profiles similar to what would be observed in the Klamath River under the Proposed Project. Salmonids in the Klamath River have been observed to use cooler hours to migrate between thermal refugia (Belchik 2003), and the decrease in minimum temperatures during the spring, summer, and fall under the Proposed Project would be beneficial for fish (Figure 3.3-3). Increased nighttime cooling of water temperatures is important to salmonids in warm systems, providing regular thermal relief, time for repair of proteins damaged by thermal stress, and significant bioenergetic benefits that help fish persist under marginal conditions (Schrank et al. 2003, NRC 2004). In addition, Dunsmoor and Huntington (2006) suggest that lower nighttime temperatures with dam removal would allow fish to leave thermal refugia in the Klamath River to forage and thereby allow more effective use of the available refugia habitat. Overall, the Proposed Project reductions in minimum daily temperatures below those under existing conditions would benefit salmonids in the Klamath River mainstem, helping them to tolerate the warmer periods of the year when dwelling in the mainstem, but also allowing feeding excursions when confined to refugia during the warmer times of the day.

Simulations of water temperatures without the Lower Klamath Project reservoirs (as discussed in Hamilton et al. 2011) show that the temperature difference with and without dams would be greatest directly downstream from Iron Gate Dam, but could extend an additional 120 to 130 river miles downstream. Estimated decreases in stream temperature with dam removal relative to existing conditions are likely to be smaller with continued climate change; however, temperature conditions for aquatic resources would be much improved under the Proposed Project as compared to existing conditions (see Potential Impact 3.2-1).

Klamath River Estuary and Pacific Ocean Nearshore Environment

The influence of the Proposed Project on water temperature would likely decrease with distance downstream from Iron Gate Dam, and it is unlikely that dam removal under the Proposed Project would have detectable effects on water temperatures in the Klamath River Estuary and Pacific Ocean nearshore environment (see Potential Impact 3.2-1).

3.3.5.5 Fish Disease and Parasites

The Proposed Project would be expected to reduce impacts on salmon from fish disease. As discussed in detail in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*, currently the greatest disease-related mortality is for juvenile salmonids due to *C. shasta* and *P. minibicornis* in the Middle Klamath River downstream from Iron Gate Dam. Among all of the salmon life stages, juvenile salmon tend to be most susceptible to *P. minibicornis* and *C. shasta*, particularly during their outmigration in the spring months (Beeman et al. 2008). The main factors contributing to risk of juvenile salmonid infection by *C. shasta* and *P. minibicornis* include availability of habitat (pools, eddies, and sediment) for the polychaete worm intermediate host *(Manayunkia speciose)*; microhabitat characteristics (static flows and low velocities); congregations of spawned adult salmon with high spore; polychaete proximity to spawning areas; planktonic food sources for polychaete from Lower Klamath Project reservoirs; and water temperatures greater than 59°F (Bartholomew and Foott 2010). For adult salmon, Ich and columnaris have occasionally resulted in substantial mortality, particularly when habitat conditions include exceptionally low flows, high water temperatures, and high densities of fish (such as adult Chinook salmon migrating upstream in the fall and holding at high densities in pools). This section addresses changes to these disease factors anticipated under the Proposed Project, and predicted affects for juvenile and adult salmonid life stages.

Removal of Iron Gate Dam and the three upstream facilities would reduce the concentration of adult salmon and carcasses that presently occurs downstream of Iron Gate Dam. Greater dispersal of spawning adult salmon would reduce their proximity to existing dense populations of polychaetes. FERC's analysis (FERC 2007) concluded that restoring access to reaches upstream of Iron Gate Dam for anadromous fish would allow adult fall-run Chinook salmon to distribute over a greater length of the river, reducing crowding and the concentration of disease pathogens that currently occur in the reach between Iron Gate Dam and the Shasta River.

Under the Proposed Project, sediment bedload transport rates would increase downstream from the current location of Iron Gate Dam which currently includes habitats with large populations of polychaetes. Under existing conditions, actinospores released from this portion of the Klamath River pass downstream and infect juvenile salmon in the current infectious zone downstream from the Shasta River to Seiad (RM 132.7)

(Bartholomew and Foott 2010). In addition, while the area of significant sediment deposition under the Proposed Project is located upstream of Cottonwood Creek, sediment transport rates would also increase downstream from Cottonwood Creek (Appendix F). This increased movement and transport of sediment (sand, silt, and clay) is anticipated to disrupt polychaete habitat from the current location of Iron Gate Dam to downstream from Shasta River, resulting in reduced actinospore releases.

Warm water temperatures increase risk of disease transmission. Dam removal would mean cooler temperatures in the late summer and fall, but slightly warmer temperatures during spring and early summer. FERC (2007) concluded that dam removal would enhance water quality and reduce the cumulative effects on water quality and habitat that contribute to disease-induced salmon die-offs in the Klamath River downstream from Iron Gate Dam. In turn, this would benefit salmon outmigrants from tributaries downstream from Iron Gate Dam, such as the Shasta and Scott rivers. Based on existing data it appears that a reduction in temperature during late summer and fall would have the effect of reducing disease rates (Bartholomew and Foott 2010). Reduced disease in the mainstem is anticipated to benefit outmigrating smolts that are currently exposed at high rates in disease hotspots.

FERC (2007) concluded that more rapid cooling of river temperatures in the fall with the Lower Klamath Project dams removed may also allow for fall Chinook salmon spawning to occur earlier in the fall. Bartholow et al. (2005) and FERC (2007) also suggest that earlier warming of the river system could trigger juvenile salmonids to out migrate earlier. This is consistent with findings that the cumulative exposure of temperature is more important predictors of migration of juvenile Chinook salmon than flow or length-of-day (Sykes et al. 2009). As previously described, increased water temperatures in the spring would likely result in earlier emergence and growth, and encourage earlier migration downstream. In addition, a slight increase in the rate at which water temperatures increase in the spring would be likely to improve the growth rates of newly emerged fall Chinook salmon fry (FERC 2007). Earlier migration downstream and improved growth would likely mean most outmigrants would avoid periods of high disease infection of juvenile salmon (Bartholow et al. 2005).

Flows also play an important role in the regulation of disease in the Klamath River. Elimination of Lower Klamath Project reservoirs under the Proposed Project would not result in major flow alterations as flows in the Klamath River are regulated through mandatory federal conditions imposed on the Klamath Irrigation Project located upstream of J.C. Boyle, but elimination of the Lower Klamath Project would create more flow variability due to peak flows from storm events no longer being retained in Lower Klamath Project reservoirs as well as a loss of flow variability in the portion of the Lower Klamath River below J.C. Boyle due to cessation of peaking operations. As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing flows have been required in 2017 and 2018, with the intent of reducing disease in the Lower Klamath River by mobilizing bedload sediments to disrupt the periphyton intermediate host (discussed below). In addition, court ordered dilution flows were required in 2018. Flushing and dilution flows are not modeled as part of existing conditions hydrology under the Proposed Project. As described in Section 3.1.6, the 2017 court-ordered flows include a requirement to ensure that certain high flows are reached each winter, and also include an emergency dilution requirement if juvenile fish disease reaches high levels in the infection nidus. The emergency dilution flows were used in 2018. While there has not been sufficient time to collect sufficient data on the efficacy of the flushing flows, the necessity to use the emergency dilution flows in 2018 suggest that the addition of the flushing flows is insufficient on its own to resolve the issue of fish disease downstream of Iron Gate Dam. Because polychaete populations are located outside of the main flow along the margins of the river (Bartholomew and Foott 2010), variable flows disrupt this habitat. Therefore, removal of the Lower Klamath Project dams would disrupt microhabitat conditions and is expected to reduce polychaete populations (Stocking and Bartholomew 2007, Bartholomew and Foott 2010) and presumably, reduce infection rates within polychaete populations both in the short and long term (Hetrick et al. 2009).

Periphyton (attached algae) provides habitat for the intermediate host of *C. shasta* and *P. minibicornis*, and would also affect disease in the Klamath River. Some of the Project's anticipated effects would tend to support increased periphytic algal growth, while others would tend to reduce it from existing conditions. Under the Proposed Project additional periphytic growth including *Cladophora* is anticipated within the Hydroelectric Reach In the long term, which could provide habitat for the intermediate host of *C. shasta* and *P. minibicornis*. The existing reservoirs foster growth of phytoplankton algae. Under a riverine system, phytoplankton's ecological advantage is reduced, and attached aquatic vegetation would tend to increase. In the absence of other factors, this could possibly increase the prevalence of the intermediate host for *C. shasta* and *P. minibicornis*. However, dam removal would also create other conditions that tend to offset the growth of aquatic vegetation. These conditions include a restoration of bedload sediment transport, increased flow variability, and a more normal (and variable), riverine temperature regime with substantially cooler fall water temperatures. FERC (2007) concluded that restoring natural sediment transport processes would likely contribute to the scour of (attached algae) downstream from the current site of Iron Gate Dam, and deposited gravel and sand would provide a less favorable substrate for periphyton because of its greater mobility during high flow events than the existing armored substrate (see also Section 3.4.5.2 *Periphyton*).

The current infectious nidus (reach with high infectivity) for *C. shasta* and *P. minibicornis* is located in the Klamath River downstream of Iron Gate Dam, where returning adult spawners congregate. Removal of the Lower Klamath Project dams would allow anadromous salmonids to move upstream in the mainstem Klamath River and tributaries upstream of Iron Gate Dam. Currently, with Iron Gate Dam blocking upstream fish passage and trapping sediment, 2017 court-ordered flushing flows are released from Iron Gate Dam for the purpose of disrupting the nidus downstream of Iron Gate Dam and reducing disease risk, although, as described above, the change in flow regime has not, in isolation, been successful in avoiding high disease concentrations. Under the Proposed Project, it is anticipated that the nidus would no longer form downstream of Iron Gate Dam, and the risk of a new nidus forming upstream is low, in the absence of the 2017 flow requirements for the reasons described above. Because the 2017 flow requirements ensure a minimum level of bedload-sediment movement in winter to disrupt the disease cycle, the likelihood of reduction in disease risk would be enhanced by including the 2017 flow requirements.

Although the conditions leading to the nidus forming downstream of Iron Gate Dam would be ameliorated, some disease factors would continue under the Proposed Project, including eight years of additional Iron Gate Hatchery operations that would potentially result in continued (through post-dam removal year 10) congregations of mostly adult fall-run Chinook salmon in the reach from Iron Gate Dam downstream to Seiad Valley

(Section 3.3.5.6 *Fish Hatcheries*). Under the Proposed Project, if a nidus were to remain in the vicinity of Iron Gate Hatchery, or theoretically were to form within newly accessible upstream habitat (however unlikely), flushing and emergency dilution flow releases as required by the 2017 court order may be required from a new upstream location to achieve the same ecological benefits (i.e., disruption of nidus).

It is unlikely that a new infectious nidus would be re-created upstream. The current infectious zone and high parasite loads below Iron Gate Dam are the result of a synergistic effect of numerous factors that occur within the current disease zone in the Klamath River from the reach from Shasta River downstream to Seiad Valley (FERC 2007, Hamilton et al. 2011, Bartholomew and Foott 2010). These factors include: (1) close proximity of myxospore-shedding carcasses (concentration of carcasses); (2) abundant polychaete populations that are found in atypically stable habitats; (3) suitable water temperatures (greater than 59°F) during periods when juvenile salmonids are present; and 4) low flow variability (Bartholomew and Foott 2010). This synergy would be unlikely in the Upper Klamath River (Hamilton et al. 2011). The likelihood of those synergistic factors developing upstream of Iron Gate Dam would be reduced as carcasses would likely be more dispersed in the watershed than occurs in the restricted habitat downstream of Iron Gate Dam (Foott et al. 2012). Iron Gate Dam is both the limit of anadromy, and the site of the current fish hatchery that accounts for a substantial proportion of all adult returning fish annually. As discussed under Section 3.3.5.3 *Water Quality*, the Keno Impoundment/Lake Ewuana has the potential to be a habitat barrier during most years for fall-run Chinook due to poor water quality during the late summer, and therefore NMFS and USFWS have prescribed fish passage measures for the Keno Impoundment/Lake Ewuana to be used during periods of poor water quality (DOI 2007). If fish passage were not provided at Keno Impoundment/Lake Ewuana, few fall-run Chinook salmon would migrate past this location, few smolts would be produced, and therefore congregations of adult fall-run Chinook salmon would be unlikely to occur since few returning adults would have a natal cue to migrate past this location. In contrast, downstream of Iron Gate Dam thousands of adults have a natal que to return to the hatchery, and congregations regular occur during the fall. Under the Proposed Project, those conditions that are believed to result in development of an infectious nidus below Iron Gate Dam or could result in development of a potential infectious nidus upstream of Iron Gate Dam, are unlikely to occur.

Historically, it appears spawning concentrations of Upper Klamath Basin Chinook salmon were located primarily in the Sprague River (Lane and Lane Associates 1981). However, there is no information indicating that high densities of polychaetes occur in the Sprague River (Foott et al. 2012). Thus, the synergistic factors that contribute to an infectious nidus for emigrants below Iron Gate Dam and near the Iron Gate Hatchery are unlikely to occur at this location under the Proposed Project either.

There is some concern regarding a disease zone in the lower Williamson River downstream from the confluence with the Sprague River, where there are currently high parasite densities observed (Hurst et al. 2012). However, there is no reason to anticipate congregations of adult migrants at this location. In addition, maximum temperatures in the Williamson River do not exceed the disease threshold of 59°F in all years (Bartholomew and Foott 2010, Hamilton et al. 2011). Overall, the risk of a juvenile salmon disease response in the Williamson River would be lower than existing conditions in the Middle Klamath River, but not negligible in all water years (S. Foott, USFWS, pers. comm., 2012).

Removal of the Lower Klamath Project dams would allow anadromous salmonids to move upstream in the mainstem Klamath River and tributaries upstream of Iron Gate Dam, altering disease dynamics between anadromous salmonids and resident species upstream of Iron Gate Dam. However, available information indicates that fish passage would not increase the risk of disease for resident species that occur upstream of Iron Gate Dam (NMFS 2006a). Pathogens (e.g., *C. shasta* and *P. minibicornis)* exist throughout the Klamath River System in both the Upper and Lower Basins, so migration of wild anadromous fish upstream and downstream from Iron Gate Dam would not increase the risk of introducing new pathogens to resident trout residing upstream of Iron Gate Dam (NMFS 2006a). In addition, native Klamath River trout are generally resistant to *C. shasta*. Recently several new *C. shasta* genotypes have been discovered in the Klamath River (described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*). Disease risk is related to host genotype specificity (Atkinson and Bartholomew 2010). It is not expected that introduction of *C. shasta* genotypes upstream would be deleterious because fish in the upstream Basin have shown resistance to the downstream genotypes. Redband trout would presumably have been exposed to genotypes of *C. shasta* during the pre-dam period, and their populations were abundant. Because the salmonid species in the Klamath Basin already co-occur with the genotype of *C. shasta* to which they are susceptible, and the salmonid species are less susceptible to other genotypes of *C. shasta*, expanding the distribution of the different genotypes of *C. shasta* would be unlikely to be deleterious to salmonids. In addition, The Chinook Salmon Expert Panel convened to attempt to answer specific questions related to the Proposed Project compared with existing conditions (Goodman et al. 2011), concluded that the Proposed Project offers greater potential than the existing conditions in reducing disease-related mortality in Klamath River Chinook salmon. Overall, movement of anadromous salmonids into the Upper Klamath Basin presents a relatively low risk of introducing pathogens to resident fish (NMFS 2006a, USFWS/NOAA Fisheries Service Issue 2(B)).

3.3.5.6 Fish Hatcheries

As described under Section 2.7.6 *Hatchery Operations*, under the Proposed Project, the Fall Creek Hatchery would be reopened, and both the Iron Gate Hatchery and Fall Creek Hatchery would continue to operate for a period of eight years following dam removal (through post-dam removal year 7, Table 3.3-11), with the following production goals (Appendix B: *Definite Plan – Section 7.8.3*):

- 3,400,000 fall-run Chinook salmon age 0 smolts at Iron Gate Hatchery (released in spring)
- 1,000,000 fall-run Chinook salmon age 1 yearling smolts at Fall Creek Hatchery (released in fall)
- 75,000 age 1 yearling coho salmon smolts at Fall Creek Hatchery (released in spring)

Although the ability to meet the production goals varies annually based on adult returns and hatchery performance, since 2005 the current fall-run Chinook salmon yearling smolt goals, and current coho salmon yearling smolt goals have been achieved on average, whereas fall-run Chinook salmon age 0 smolts are typically about a million smolts shy of current production goals (K. Pomeroy, CDFW, pers. comm., 2018). Considering actual production achieved, hatchery operations under the Proposed

Project would constitute a reduction in production goals from existing conditions of around 87 percent for yearling fall-run Chinook salmon smolts, 20 percent for fall-run Chinook salmon age 0 smolts, 100 percent for steelhead (although no steelhead have been released since 2012), and no change in production goals for coho salmon smolts. Moving production and releases from Iron Gate Hatchery to Fall Creek Hatchery is not anticipated to have a discernable effect on aquatic resources.

A Hatchery Genetic Management Plan (HGMP) for the Iron Gate Hatchery (CDFW 2014) recently redefined the operation of this hatchery from a mitigation hatchery to one now operated to protect and conserve the genetic resources of the Upper Klamath population unit of the SONCC coho salmon ESU. Included in the HGMP are defined monitoring and evaluation activities to evaluate effects of the hatchery activities on the abundance, productivity, spatial structure, and diversity of the SONCC coho salmon and the magnitude or relative impact of the hatchery program on other actions that influence SONCC coho salmon. Operation of the Fall Creek Hatchery would therefore be managed with a particular focus on supporting recolonization of coho salmon in newly accessible habitat.

For the first eight years following dam removal, the effect of hatchery production on aquatic resources would be similar to existing conditions, as described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*. The continuation of production (albeit reduced) would affect adult returns for fall-run Chinook and coho salmon, as described for species specific aquatic resource impacts in Section 3.3.5.9 *Aquatic Resource Impacts*.

The elimination of hatchery production eight years after Lower Klamath Project dam removals under the Proposed Project would affect aquatic resources in the Area of Analysis. When production is ceased (post-dam removal year 7), adult coho salmon progeny of hatchery releases would potentially continue to return through post-dam removal year 9 (three-year old returns released as age 1), and hatchery adult fall-run Chinook salmon through post-dam removal year 10 (four-year old returns released in post-dam removal year 7) (Table 3.3-11). After post-dam removal year 3, fewer coho and Chinook salmon adults would possess a natal cue to return to the location of Iron Gate Hatchery (and none after post-dam removal year 10), because there would be fewer smolts released there starting in dam removal year 2, and no artificial supplementation of the population from that location after post-dam removal year 7. In addition, during post-dam removal years 7 through 10 for fall-run Chinook salmon and dam removal years 7 through 9 for coho salmon hatchery adults would continue to return to Iron Gate or Fall Creek hatcheries (natal cue) but would not be collected. For this three to four-year period, straying of hatchery adults into areas of natural spawning may increase. Straying has the potential to reduce the reproductive success of natural salmonid populations (Mclean et al. 2003, Chilcote 2003, Araki et al*.* 2007) and negatively affect the genetic diversity of the populations (Reisenbichler and Rubin 1999). Based on the current low numbers of adult returns of coho salmon, increased straying into Fall Creek for a few years is unlikely to have a substantial effect. Fall-run Chinook salmon adults straying into Bogus Creek and Fall Creek may be high during this period, but there would also be greater access to newly available habitat, likely dispersing adults over a greater area and reducing potential impacts.

The current infectious nidus for salmonid smolts (i.e., reach with highest infectivity) for *C. shasta* and *P. minibicornis* appears to be the result of the synergistic effect high spore input from heavily infected, spawned adult salmon that congregate downstream from Iron Gate Dam and Iron Gate Hatchery and the proximity to dense populations of polychaetes (Bartholomew et al. 2007). Juveniles released from Iron Gate Hatchery may also contribute to the infectious nidus (Som et al. 2016a), as hatchery-released juvenile fish that become infected and experience mortality further downstream in the Klamath River and potentially become another source of myxospores threatening aquatic resources in the Lower Klamath River. The greater dispersal of release locations of smolts (Iron Gate Hatchery and Fall Creek Hatchery) starting in post-dam removal year 1 would reduce density of juveniles in that year, and reduce congregations of adults by post-dam removal year 3, and therefore reduce the risk of the infectious nidus forming in the Middle Klamath River in the short-and long-term.

Table 3.3-11. Hatchery releases and adult returns under the Proposed Project.

Species		Dam Removal Year		Post-dam Removal Year							
		1	2[a]	1	2	3	4	5–7[b]	8	9	10
Chinook salmon	Produced	N smolts from existing habitat and existing H smolts (age 0 in spring and age 1 in fall)	N smolts from existing habitat and reduced H smolts	N smolts from new habitat and reduced H smolts	N and reduced H smolts	N and reduced H smolts	N and reduced H smolts	N and reduced H smolts	N smolts	N smolts	N smolts
	Returning	N and H adults (age 3–4) downstream of Iron Gate Dam	N and H adults access new habitat	N and H adults	N and H adults	N adults from new habitat (progeny of post-dam removal year 1 outmigration) and reduced H adults	N and reduced H adults	N and reduced H adults	N and reduced H adults	N and reduced H adults	N adults and last H adults (age 4, progeny of post-dam removal year 7 outmigration)
Coho salmon	Produced	N smolts from existing habitat and H smolts (age 1)	N smolts from existing habitat and H smolts	N smolts from new habitat and H smolts from Fall Creek	N and H smolts	N and H smolts	N and H smolts	N and H smolts	N smolts	N Smolts	N smolts
	Returning	N and H (age 3) downstream of Iron Gate Dam	N and H adults access new habitat	N and H adults	N and H adults	N adults from new habitat (progeny of post-dam removal year 1 outmigration) and H adults	N and H adults	N and H adults	N and H adults	N and last H adults (progeny of post-dam removal year 7 outmigration)	N adults

[a] Early drawdown of Copco No. 1 begins in dam removal year 1. Drawdown of all reservoirs occurs and dams are removed in dam removal year 2 (see Table 2.7-1). Reduced hatchery releases begin in dam removal year 2 and continue for eight years until post-dam removal year 7.
[b] Final year of hatchery releases occurs in post-dam removal year 7.
H smolt from hatchery releases or adult progeny of hatchery release
N smolt from natural spawning or adult progeny of natural spawning

Overall, dispersing hatchery operations in the short term and discontinuing hatchery operations after eight years following Lower Klamath Project dams removal would reduce the risk of nidus forming in the mainstem Klamath River in the short- and long-term. In addition, hatchery juveniles would no longer be released after post-dam removal year 7 during natural smolt outmigration. Therefore, it is anticipated that the Proposed Project would result in reduced impacts to aquatic resources due to fish disease and parasites in the short- and long-term. Population and other impacts of altered hatchery operations vary for aquatic species and are discussed for specific impacts below.

3.3.5.7 Algal Toxins

The removal of the Lower Klamath Project reservoirs, particularly the larger Copco No. 1 and Iron Gate reservoirs, would decrease or eliminate excessive growth of phytoplankton, and in particular large seasonal blooms of blue-green algae and associated toxins (e.g., microcystin), by eliminating large areas of quiescent habitat where these phytoplankton species currently thrive. In the nutrient-rich Klamath River system, the elevated water temperatures and increased light levels that occur during the summer and early fall under existing conditions result in seasonal blue-green algae blooms in the phytoplankton and periphyton Area of Analysis, and especially the Hydroelectric Reach (Section 3.4.2.3 *Hydroelectric Reach*). As analyzed in Potential Impact 3.4-2, the Proposed Project would dramatically decrease the amount of optimal (calm, slow-moving reservoir) habitat available to support nuisance and/or noxious phytoplankton species, resulting in a corresponding decrease in phytoplankton blooms, alleviating high seasonal concentrations of algal toxins and associated bioaccumulation of microcystin in fish and freshwater mollusk tissue for species downstream of the Lower Klamath Project reservoirs.

While some microcystin may be transported to downstream reaches of the Klamath River from large blooms occurring in Upper Klamath Lake, the levels would not be nearly as high as those experienced under existing conditions, because seasonal blooms in Copco No. 1 and Iron Gate reservoirs are the primary source of *Microcystis aeruginosa* to the Middle and Lower Klamath River (see Section 3.4.2 *Phytoplankton*). Overall, bioaccumulation of algal toxins in freshwater mollusk and fish tissue would be expected to decrease in the mainstem Klamath River from the Hydroelectric Reach to the Klamath River Estuary.

3.3.5.8 Aquatic Habitat

As described in Section 2.1 *Project Objectives*, a primary purpose of the Proposed Project is to increase habitat availability for anadromous salmonids in the Klamath River, for the benefit of the salmonid populations and the recreational, commercial, and cultural uses related to the health of the salmon fishery. The Proposed Project is intended to increase the amount of aquatic habitat by removing migration barriers, and also to improve the quality of the habitat, as related to the operation of the existing hydroelectric facilities. There is some disagreement among experts as to the amount of habitat that Chinook salmon and steelhead would be able to reach, based primarily[90] on the impact of water quality problems in the Lake Ewauna/Keno Reservoir reach and in Upper

[90] Both dams that would remain under the Proposed Project (Keno Dam and Link River Dam), have fish passage facilities.

Klamath Lake, discussed in greater detail in Upper Klamath River and Connected Waterbodies, immediately below. Because coho salmon are not expected to migrate to these reaches, the same concern does not affect estimates of additional coho habitat.

It is worth noting that based on comments received during the public scoping process (Appendix A), it appears that there is concern from some about the historic distribution of salmonids in the Klamath River Basin, with individuals asserting that historical geomorphic features or water quality may have limited upstream migration prior to dam construction (see below paragraph). However, as this document is an analysis of habitat availability upon implementation of the Proposed Project, including consideration of existing and projected future river conditions, this EIR does not further address questions of the historic distribution of salmonids in the Klamath River Basin.

A few commenters (Appendix A) have suggested that a reef existed at the location of Copco No. 1 Dam that would have limited anadromous salmon passage. Boyle (1976) describes an andesite "reef" at the location of Copco No. 1 Dam prior to dam construction and reservoir inundation. He observed evidence of a historical lake formed by this reef that extended approximately five river miles upstream. While the reef may have been a barrier to migration of Chinook salmon when it was originally formed, Boyle is clear that the reef was one of the oldest exposed formations found in the Siskiyou Mountains, and that this barrier and lake existed in the geologic history. At the time of Copco No. 1 Dam construction, no impediments to upstream Chinook salmon migration were described by Boyle. Boyle (1976) describes large runs of salmon at the site of Copco No. 1 in the early 1900's, and details that a fish ladder was considered for construction at Copco No. 1 Dam, but in coordination with California Fish and Game Commission a fish hatchery was proposed for Fall Creek in lieu of passage. Further, historical records reviewed by Hamilton et al. (2005) and Hamilton et al. (2016), and genetic information obtained from archaeological sites analyzed by Butler et al. (2010), indicate that prior to the construction of Copco No. 1 Dam, Chinook salmon (fall- and spring-run based on observed and documented timing) were abundant in, and spawned in, tributaries of the Upper Klamath Basin (i.e., upstream of the described reef and eventual location of Copco No. 1 Dam), Shovel and Spencer creeks, as well as the Sprague, Williamson, and Wood rivers. This conclusion was further recognized in a trial-type hearing concerning federal fisheries requirements in *Klamath Hydroelectric Project* (FERC Project No. 2082, Docket # 2006-NMFS-0001) (Sept. 29, 2006) (hereinafter "NMFS 2006a"). Thus, it appears that there was no "reef" forming a barrier to fish migration at the time Copco No. 1 was built.

The habitat quantity and quality that would be accessible under the Proposed Project within the Area of Analysis are described below for each of the key reaches.

Upper Klamath River and Connected Waterbodies

Removal of the four hydroelectric dams eliminates all of the impassable dams that prevent salmon from accessing an estimated 360 miles of potential anadromous fish habitat upstream of Upper Klamath Lake and Keno Impoundment/Lake Ewauna, with key habitat tributaries being the Woods, Williamson and Sprague rivers (Huntington 2006, DOI 2007, NMFS 2007b). However, FERC's (2007) analysis of habitat access for anadromous fish with fish passage excluded these 360 miles of anadromous fish habitat based upon poor water quality conditions in Upper Klamath Lake and Keno Impoundment/Lake Ewauna during summer months. The Chinook Salmon Expert Panel (Goodman et al. 2011) also concluded that substantial gains in Chinook salmon abundance for areas upstream of Keno Impoundment/Lake Ewauna would be contingent upon successfully resolving limitations associated with poor water quality problems in Upper Klamath Lake and Keno Impoundment/Lake Ewauna. The Coho Salmon and Steelhead Expert Panel (Dunne et al. 2011) stated that poor water quality in Keno Impoundment/Lake Ewauna and in Upper Klamath Lake, and the possibility of difficult passage at Keno Dam, could impede steelhead from reaching improved habitat in the Upper Klamath River. Note that as discussed above (Section 3.3.2.2 *Physical Habitat Descriptions*), fish passage at Keno Dam is in the process of being improved by the USBR.

These concerns for anadromous salmonid migration and spawning overstate the seasonal habitat limitations of Keno Impoundment/Lake Ewauna and Upper Klamath Lake because of the manner in which the seasonal water quality impairments intersect with steelhead, spring-run Chinook, and certain fall-run Chinook life histories.

Regarding Upper Klamath Lake's availability as habitat/migration corridor, a study by Maule et al. (2009) strongly suggests that Upper Klamath Lake habitat can support salmonids, except during the summer (June through September). Maule et al. (2009) examined the response of salmon to Upper Klamath Lake under existing conditions. Iron Gate Hatchery Chinook salmon were tested in the lake and the lower Williamson River to assess whether existing conditions would physiologically impair salmon reintroduced into the Upper Klamath Basin. Juvenile Chinook salmon were tested in cages in 2005 and 2006. These juveniles showed normal development as smolts in Upper Klamath Lake and survived well in both locations (Maule et al. 2009). Maule et al. (2009) concluded that there was little evidence of physiological impairment or significant vulnerability to *C. shasta* that would preclude this stock from being reintroduced into the Upper Klamath Basin. In addition, the dominant life history of fall-run Chinook salmon (Type I) outmigrate to the ocean in spring and would not rear during the stressful summer period in the Upper Klamath Basin. Type II and Type III life history would rear during summer and outmigrate during either fall (Type II) or spring (Type III). Thus, conditions for juvenile fall-run Chinook emigration through Upper Klamath Lake appear favorable. Due to the spring migration period for adult and juvenile spring-run Chinook salmon and steelhead, the migratory life stages would generally avoid the period of poor water quality in Upper Klamath Lake as well. Cool groundwater spring inputs in the Williamson River and on the west side of Upper Klamath Lake would likely provide thermal refugia for the non-migratory juvenile salmonid rearing life stages.

Similar to the severe water quality impairments in Upper Klamath Lake, the serious water quality issues in Keno Impoundment/Lake Ewauna are not year round. Both DOI and NMFS have long recognized the issue of seasonally poor water quality typically between June 15 and November 15 in Keno Impoundment/Lake Ewauna. This is a time period when nearly all adult fall- and some (later portion) spring-run Chinook salmon would be migrating upstream. When water quality is poor both DOI and NMFS prescribed the transfer of primarily adult fall-run Chinook salmon upstream of the Keno Impoundment/Lake Ewauna for the purposes of restoration and safe, effective, and timely passage (DOI 2007, NMFS 2007b). If fish passage were not provided, upstream migrating adults would presumably locate spawning habitat downstream.

Upper Klamath River - Hydroelectric Reach

This reach would be fundamentally altered under the Proposed Project, with the removal of the dams and associated reservoirs, and the restoration of riverine systems and habitat connectivity. Under the Proposed Project anadromous fish (Chinook salmon, steelhead, coho salmon, and Pacific lamprey) access would be restored to an estimated 80 miles of habitat within the mainstem Klamath River and tributaries upstream of Iron Gate Dam and downstream of Keno Dam (DOI 2007, Cunanan 2009). Primary tributary habitat that would be available for salmonids includes Fall, Jenny, Shovel, and Spencer creeks. In addition to the tributaries and the current reaches of the mainstem, the 80 miles of habitat includes restoration of 21.2 miles of currently inundated mainstem and tributary riverine habitat (Cunanan 2009) for resident and anadromous fish. The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided high quality salmonid spawning and rearing habitats (Hetrick et al. 2009). Modeling indicates that the river would return to a similar channel morphology following dam removal, ad discussed in Appendix F. In addition, proposed habitat restoration within the reservoir areas (described in Section 2.7.4 *Restoration Within the Reservoir Footprint*) is designed to slow water velocities along the bank and thus has the potential to create backwater and rearing habitat for coho salmon. Proposed habitat restoration components include manually creating connectivity to tributaries, incorporating floodplain habitat features (e.g., side channels), creating bank-line complexity to slow water velocities, and placing large wood habitat features (Appendix B: *Definite Plan*).

Under the Proposed Project, short-term alterations to the hydrograph would result from the release of water stored in the Lower Klamath Project reservoirs. Based on modeling results, this release is expected to last about three months, from January 1 into mid-March of dam removal year 2, but could vary depending on hydrologic conditions (USBR 2012), increasing the magnitude of flows downstream from the dams during the drawdown period. River flows would be expected to remain below the 10-year flood event.

In the long term flows would increase not only in the bypass reaches, but also in all other mainstem reaches due to changes in operations and the absence of reservoir evaporation. Hydrology in the J.C. Boyle Peaking Reach would follow the natural hydrograph more closely, including increased duration and magnitude of high flows, and cessation of daily extreme flow fluctuations (characteristic of hydroelectric peaking operations).

Increases in flows resulting from changes in peaking operations at J.C. Boyle Dam would provide more habitat than under existing conditions for redband/rainbow trout and other resident riverine species, as well as anadromous fish or lamprey that reestablish in this area. These flows are expected to meet channel maintenance needs to route coarse sediments, build bars, erode banks, flush fine sediments, scour vegetation and undercut and topple large woody riparian vegetation (NRC 2008). The removal of Lower Klamath Project dams would reestablish geomorphic and vegetative processes that form channels that provide fish habitat and spawning gravels in this reach, especially in the former bypassed reaches (FERC 2007). In addition, the impacts associated with daily extreme flow fluctuations resulting from hydroelectric peaking operations (e.g., stranding, displacement, reduced food production, and increased stress) would no longer occur.

Middle and Lower Klamath River

As described above, reservoir drawdown under the Proposed Project would result in increased flows for about four months once drawdown begins. Over the long term, the Proposed Project would alter the hydrograph so that the duration, timing, and magnitude of flows would be more similar to the unregulated conditions under which the native fish community evolved (Hetrick et al. 2009). While mean annual flows would not substantially change from existing flows due to the lack of active reservoir storage (Stillwater Sciences 2009b, USBR 2012), daily, seasonal, and annual flow variability would increase. It is anticipated that restoration of the hydrologic function of the river system under the Proposed Project would support the creation of habitat diversity and maintain biophysical attributes of the Klamath River (Stanford et al. 1996, Poff et al. 1997).

The Proposed Project would substantially decrease the transit time of water in the Hydroelectric Reach, because it would no longer be impounded by the reservoirs, resulting in a shift in the timing of the occurrence of low flow periods to earlier in summer than currently occurs (Balance Hydrologics Inc. 1996, NRC 2004). These hydrologic effects would likely be more important in upstream areas (directly downstream from Iron Gate Dam) than downstream areas (downstream from the confluence of the Scott River) due to the substantial flow contribution of tributaries to the Klamath River (USBR 2012). In addition, these hydraulic changes would result in changes to water quality, water temperatures, sediment transport, and riparian habitat, as described in subsequent sections.

Klamath River Estuary and Pacific Ocean Nearshore Environment

Hydrologic and hydraulic modeling results (described in Section 3.6.2.3 *Flood Hydrology*) indicate that because of the influence of the tributaries entering the Klamath River downstream from Iron Gate Dam, the flow changes for the Proposed Project would not substantially affect the flows entering the estuary. Specifically, Potential Impact 3.6-1 and Potential Impact 3.6-3 provide further discussion and information on this effect. Therefore, the Proposed Project would not affect flow-related fisheries habitat in the estuary or the Pacific Ocean.

3.3.5.9 Aquatic Resource Impacts

Potential Impact 3.3-1 Effects on coho salmon critical habitat quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

In the short term, under the Proposed Project, designated critical habitat supporting SONCC coho salmon would be degraded from elevated SSCs and sediment deposition downstream of Iron Gate Dam (see Section 3.3.5.1 *Suspended Sediment* and Appendix E of this EIR, and Section 3.3.5.2 *Bed Elevation and Grain Size Distribution* and Appendix F of this EIR). The specific features of critical habitat and designated PCEs considered essential for the conservation of the SONCC ESU that would be adversely impacted in the short term include spawning substrate, water quality, and safe passage conditions. Quality of spawning substrate for coho salmon downstream of Iron Gate Dam would be substantially degraded during the spawning season following dam removal, while most of the spawning habitat occurring in tributaries would remain unaltered by the Proposed Project (Appendix E). Water quality in the mainstem Klamath River downstream of Iron Gate Dam would be substantially degraded in the short term from increased suspended sediment and decreased dissolved oxygen, resulting in a substantial reduction in rearing and migration habitat suitability for juvenile and smolt coho salmon during the winter and spring following dam removal (Appendix E). Passage conditions would be impaired for adult upstream migrants during the fall and winter of dam removal from both increased suspended sediment, and the risk of sediment deposits at tributary confluences (Appendices E and F). Passage conditions would be impaired for coho salmon smolts during spring following dam removal from increased suspended sediment (Appendix E). Based on the substantial short-term decrease in quality of the features of critical habitat and PCEs supporting SONCC coho salmon, there would be a significant impact to coho salmon critical habitat under the Proposed Project in the short term.

However, the Proposed Project includes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) to reduce the short-term effects of SSCs on coho salmon PCEs of critical habitat. In addition, mitigation measures AQR-1 and AQR-2 (described below), would be required to increase certainty of the effectiveness of the aquatic resource measures AR-1 and AR-2 and to reduce the short-term significant adverse impacts of the Proposed Project on coho salmon critical habitat. Aquatic resource measures submitted as part of the Proposed Project are summarized in Section 2.7.8.1 *Aquatic Resource Measures* and detailed in Appendix B: *Definite Plan − Appendix I*. AR-1 includes the development and implementation of a monitoring and adaptive management plan to offset the impacts of Lower Klamath Project dam removal on mainstem spawning habitat. AR-1 actions include a 2-year tributary confluence monitoring effort and addressing sediment and debris obstructions that block volitional upstream passage from the Klamath River into tributaries. Monitoring would occur periodically for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No. 11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-1 Mainstem Spawning (detailed below) further specifies that monitoring shall also be conducted following a significant flow event, even if that flow event occurs more than two years following dam removal. Aquatic Resource Measure AR-1 also includes a spawning habitat evaluation on the Klamath River and tributaries in the Hydroelectric Reach. Most coho salmon spawning occurs in tributaries, and very few coho salmon have been observed spawning in the mainstem Klamath River. Therefore, the spawning habitat actions of AR-1 are focused on offsetting impacts of the Proposed Project on Chinook salmon and steelhead. However, due to the similar spawning habitat requirements of coho salmon to both species, these actions would benefit coho salmon as well. If spawning habitat conditions following dam removal do not meet target metrics[91] developed to offset the anticipated loss of Chinook salmon and steelhead redds due to the Proposed Project, AR-1 specifies that spawning gravel augmentation would be completed within the mainstem, with additional spawning habitat actions within tributaries. These tributary spawning habitat restoration actions would be completed in Jenny Creek, Shovel Creek, Fall Creek, and/or Spencer Creek and could include removal of artificial fish passage barriers, or placement of large woody debris to trap and retain spawning gravels. Mitigation Measure AQR-1 Mainstem Spawning (detailed below) further specifies the range of actions that shall be conducted in tributaries to offset impacts to critical habitat. Implementation of the Proposed Aquatic Resource Measure AR-1 along with Mitigation Measure AQR-1 would reduce the short-term

[91] Spawning gravel in the amount of 44,100 yd^2 for fall Chinook salmon and 4,700 yd^2 for steelhead

potential impacts of SSCs on coho salmon spawning habitat in dam removal year 2 by improving access to tributary habitat where impacts from SSC on habitat in the mainstem can be avoided, and by augmenting spawning gravel, ensuring that suitable spawning habitat in mainstem and tributaries is available following dam removal. Given implementation of AR-1 and AQR-1, suitable coho salmon spawning habitat quality and quantity would not be substantially reduced as a result of the Proposed Project.

Proposed Aquatic Resource Measure AR-2 includes three primary actions: 1) salvaging mainstem overwintering juvenile salmonids prior to reservoir drawdown; 2) maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River; and 3) developing a water quality monitoring network, trigger thresholds, and plan for salvaging and relocating juvenile fish from tributary confluence areas to cold water tributaries or nearby off-channel ponds. Implementation of proposed Aquatic Resource Measure AR-2 would reduce the short-term effects of SSCs on rearing habitat for coho salmon juveniles in the mainstem during dam removal by actively transporting up to 500 juvenile coho salmon from vulnerable mainstem areas to off-channel ponds protected from the effects of the Proposed Project, thus offsetting water quality impacts to critical habitat. Other native fish captured during the seining and trapping effort, such as juvenile steelhead and juvenile Chinook salmon would be relocated into tributary streams adjacent to the salvage locations. Proposed Aquatic Resource Measure AR-2 would also reduce the potential short-term effects of SSCs to migratory habitat for coho salmon smolts by maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River. Monitoring would occur regularly for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No.11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-2 Juvenile Outmigration (detailed below) further specifies that monitoring shall also be conducted following a significant flow event, even if that flow event occurs more than two years following dam removal. In addition, proposed Aquatic Resource Measure AR-2 would reduce the potential short-term effects of SSCs to migratory habitat for coho salmon smolts by rescuing and transporting smolts if mainstem SSC are high, and water temperatures within tributaries are too poor to provide safe refuge (a decision to be made in regular consultation with the Aquatic Technical Work Group [ATWG[92]]). These measures would effectively provide juvenile coho salmon short-term refuge in suitable habitat as an alternative to exposure to temporarily degraded critical habitat from periods of high SSC in the mainstem habitat following dam removal.

Based on the wide distribution of coho salmon critical habitat within tributaries, implementation of the KRRC's proposed aquatic resource measures (AR-1 and AR-2), and implementation of the mitigation measures (AQR-1 and AQR-2) developed for this EIR (where both sets of measures were designed to offset short-term impacts to PCEs of critical habitat), there would not be a substantial decrease in the quality of a substantial proportion of habitat for coho salmon critical habitat in the short term. Therefore, the Proposed Project would have no significant impact on coho salmon critical habitat in the short term.

[92] The ATWG would be comprised of agency and tribal fisheries scientists to review the aquatic resource (AR) mitigation measures included in the Proposed Project.

In the long term, the Proposed Project would increase the amount of habitat available to coho salmon upstream of currently designated critical habitat and improve water quality and bedload characteristics in the mainstem Klamath River within current critical habitat.

The Proposed Project would restore access for Upper Klamath River coho salmon populations to the Hydroelectric Reach. The 2006 administrative trial-type hearings evaluating fish passage mandatory conditions found that the record of evidence is inconclusive as to whether coho salmon's historical distribution extended upstream as far as Spencer Creek, but that the evidence definitively shows that based on historical records and tribal accounts coho salmon used habitat as far upstream as Fall Creek (NMFS 2006a). Based on Hamilton et al. (2005), the Proposed Project would expand coho salmon distribution to include historical high-quality spawning and rearing habitat along the mainstem Klamath River and all tributaries upstream at least as far as Spencer Creek, including in Jenny, Shovel, and Fall creeks. Together, this compromises around 80 miles of suitable potential habitat within the Hydroelectric Reach (DOI 2007, Cunanan 2009). Access to suitable habitat upstream of Iron Gate Dam would increase the availability of spawning sites, result in additional food resources, and provide access to areas of better water quality.

NMFS may consider whether to designate the newly available habitat as critical habitat as part of its five-year status review or as a separate reconsideration of the critical habitat designation for the species (J. Simondet, NMFS, pers. comm., 2011). But, it is speculative at this point to prejudge the outcome of any such consideration, so the EIR does not find that the anticipated coho habitat expansion would necessarily result in an increased in the amount of designated critical habitat.

As discussed in detail in Potential Impact 3.2-1, the thermal lag formerly caused by water storage in reservoirs and the associated increased thermal mass would be eliminated in the Lower Klamath River. This would result in Klamath River water temperatures that exhibit more natural diel (i.e., 24-hour period) variation and are more in sync with historical migration and spawning periods. These changes would result in water temperatures that are more favorable for salmonids in the mainstem Klamath River in the long term, thus improving the water quality PCE of critical habitat. Removal of the Lower Klamath Project dams and associated facilities would also increase dissolved oxygen concentrations and eliminate reservoir habitat that creates the conditions necessary for the growth of blue-green algae and other phytoplankton. Under the Proposed Project, increased bedload supply and transport following dam removal would increase the supply of gravel downstream from the removed dams as far downstream as Cottonwood Creek (see Appendix F). In the long term this would likely improve critical habitat for coho salmon by reducing median substrate to a size more favorable for spawning (USBR 2012).

Overall, these changes would be a substantial increase in the quality and quantity of coho salmon critical habitat in the long term. Therefore, the Proposed Project would be beneficial for coho salmon critical habitat in the long term.

Mitigation Measure AQR-1 – Mainstem Spawning.
Implementation of Action 1 of proposed Aquatic Resource Measure AR-1 (tributary-mainstem connectivity) shall be implemented in the tributaries identified in Action 1 of AR-1, as well as all newly created stream channels that were previously inundated by Project reservoirs prior to drawdown. As described in Appendix B: *Definite Plan –*

Appendix I, implementation of Action 1 of proposed Aquatic Resource Measure AR-1 would be conducted for at least two years following dam removal, including following a 5-year flow event if the event were to occur within that two years. This mitigation measure (AQR-1) ensures that in addition to the monitoring that shall be conducted as described for AR-1, monitoring shall also be conducted within one month following a 5-year flow event regardless of how many years since dam removal have passed, and if fish passage obstructions are identified, they shall be removed as described in AR-1 (Appendix B: *Definite Plan − Appendix I*). In addition, implementation of Action 1 of proposed Aquatic Resource Measure AR-1 shall include an evaluation and proposal of other actions to improve spawning and rearing habitat in tributaries to the Klamath River that meet the spawning targets identified in AR-1, which may include: installation of large woody material, riparian planting for shade coverage, wetland construction or enhancement, and cattle exclusion fencing.

Mitigation Measure AQR-2 – Juvenile Outmigration.
Implementation of Action 2 of proposed Aquatic Resource Measure AR-2 (tributary-mainstem connectivity monitoring) shall be implemented in the tributaries identified in Action 2 of AR-2 as well as all newly created stream channels that were previously inundated by Lower Klamath Project reservoirs prior to drawdown. As described in Appendix B: *Definite Plan − Appendix I*, implementation of Action 2 of AR-2 would be conducted for at least two years following dam removal, including following a 5-year flow event, if the event were to occur within that two years. This mitigation measure (AQR-2) ensures that in addition to monitoring described under AR-2, monitoring shall also be conducted within one month following a 5-year flow event regardless of how many years since dam removal have passed, and requires that if fish passage obstructions are identified in relation to the Proposed Project, they shall be removed as described in AR-2 (Appendix B: *Definite Plan − Appendix I*).

Significance
No significant impact with mitigation to coho salmon critical habitat in the short term

Beneficial for coho salmon critical habitat in the long term

Potential Impact 3.3-2 Effects on Southern Resident Killer Whale critical habitat quality due to short-term and long-term alterations to salmon populations due to dam removal.
The Klamath River contributes to critical habitat for Southern Resident Killer Whales through its contribution of salmon to their food supply (included as a PCE). The Proposed Project would not affect the geographic extent of critical habitat for this species, as it is located in the state of Washington. In the short term, salmon population abundance is anticipated to reduce under the Proposed Project, as described in Potential Impacts 3.3-7, 3.3-8, and 3.3-9. In the long term, the Proposed Project is expected to increase salmon populations (as described in Potential Impacts 3.3-7, 3.3-8, and 3.3-9), which could increase food supply for Southern Resident Killer Whales. However, data on the Southern Resident Killer Whale diet indicate that based on the migratory range and behavior of the population, the Klamath River salmon are anticipated to provide less than one percent of the diet of Southern Resident Killer Whales in most months under current and future conditions. While Southern Resident Killer Whales have been shown to consume Klamath River Chinook Salmon, the Klamath River is considered by NMFS and WDFW tenth out of the top ten priority Chinook Salmon populations for Southern Resident Killer Whales (NMFS 2018b, NMFS

and WDFW 2018). Because of the low proportion of the Sothern Resident Killer Whale diet being composed of salmon from the Klamath River, the Proposed Project would not be likely to substantially impact the habitat quality (i.e., food supply) of Southern Resident Killer Whales in the short term or long term. Therefore, the Proposed Project would have no significant impact to Southern Resident Killer Whale critical habitat in the short term and long term.

Significance

No significant impact to Southern Resident Killer Whale critical habitat in the short term

No significant impact to Southern Resident Killer Whale critical habitat in the long term

Potential Impact 3.3-3 Effects on eulachon critical habitat quality due to short-term sediment releases due to dam removal.

In the short term, under the Proposed Project, PCEs of critical habitat supporting eulachon would be degraded, including short-term adverse effects of suspended sediment (see Section 3.3.5.1 *Suspended Sediment* and Appendix E) primarily on spawning and egg incubation habitat, and adult and larval migration habitat (NMFS 2011) during eulachon spawning, and adult and larval migration period (primarily January through April). Eulachon are highly adapted to migrating and spawning during periods of increases suspended sediment, and suspended sediment released under the Proposed Project is predicted to be at levels similar to what occurs under existing conditions within the Klamath River Estuary, at least during infrequent storm events.

Critical habitat for the Southern DPS eulachon includes approximately 539 miles of riverine and estuarine habitat in California, Oregon, and Washington, of which the Klamath River Estuary is a small proportion (less than two percent). Although the Proposed Project could result in short-term reductions in habitat quality detrimental to PCEs (potentially spawning substrate composition during the year of dam removal) under a worst impacts on fish scenario, a negligible amount (less than two percent) of eulachon critical habitat would be effected for a short duration. Therefore, impacts to eulachon critical habitat would not be significant in the short term.

In the long term, SSCs would be similar to those under existing conditions. Natural bedload transport processes would resume, as the dams would no longer trap sediment supplied from areas upstream of Iron Gate Dam (see Appendix F). Channel bed elevations and grains size in the estuary and ocean would not be appreciably affected, because of the small contribution of the area upstream of Iron Gate Dam to the total bedload in the system. Water quality benefits resulting from the Proposed Project would largely have dissipated upstream of the estuary, and therefore, water quality in the estuary would be expected to remain un-altered in the long term (WQST 2011). Therefore, there would be no impact to eulachon critical habitat in the long term.

Significance

No significant impact to eulachon critical habitat in the short term

No significant impact to eulachon critical habitat in the long term

Potential Impact 3.3-4 Effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

In the short term, under the Proposed Project, Chinook and coho salmon Essential Fish Habitat (EFH) is identical for both species and would be degraded from elevated SSCs and sediment deposition downstream of Iron Gate Dam (see Section 3.3.5.1 *Suspended Sediment* and Appendix E of this EIR, and Section 3.3.5.2 *Bed Elevation and Grain Size Distribution* and Appendix F of this EIR). The specific features of EFH that would be adversely impacted in the short term include water quality necessary for successful adult migration and holding, spawning, egg-to-fry survival, fry rearing, smolt migration, and estuarine rearing of juvenile Chinook and coho salmon. Water quality in the mainstem Klamath River downstream of Iron Gate Dam would be substantially degraded in the short term from increased suspended sediment and decreased dissolved oxygen, resulting in a substantial reduction in rearing and migration habitat suitability for juvenile and smolt Chinook and coho salmon during the winter and spring following dam removal (Appendix E). Passage conditions would be impaired for adult upstream Chinook and coho salmon migrants during the fall and winter of dam removal from both increased suspended sediment, and the risk of sediment deposits at tributary confluences (Appendices E and F). Quality of spawning substrate for Chinook and coho salmon downstream of Iron Gate Dam would be substantially degraded during the spawning season following dam removal, while most of the spawning habitat occurring in tributaries would remain unaltered by the Proposed Project (Appendix E). Passage conditions would be impaired for Chinook and coho salmon smolts during spring following dam removal from increased suspended sediment (Appendix E). Based on the substantial short-term decrease in quality of EFH for Chinook and coho salmon, there would be a significant impact to Chinook and coho salmon EFH under the Proposed Project in the short term.

However, the Proposed Project includes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) to reduce the short-term effects of SSCs on Chinook and coho salmon EFH. In addition, mitigation measures AQR-1 and AQR-2 (described above for Potential Impact 3.3-1), would be required to increase certainty of the effectiveness of the aquatic resource measures AR-1 and AR-2 and reduce the potential for short-term significant adverse impacts of the Proposed Project on Chinook and coho salmon EFH. Aquatic resource measures are summarized in Section 2.7.8.1 *Aquatic Resource Measures* and detailed in Appendix B: *Definite Plan − Appendix I*. Proposed Aquatic Resource Measure AR-1 includes the development and implementation of a monitoring and adaptive management plan to offset the impacts of Lower Klamath Project dam removal on mainstem spawning habitat. Proposed Aquatic Resource Measure AR-1 actions include a 2-year tributary confluence monitoring effort and addressing sediment and debris obstructions that block volitional upstream passage from the Klamath River into tributaries. Monitoring would occur regularly for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No. 11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-1 Mainstem Spawning (described in detail in Potential Impact 3.3-1), developed for this EIR, further specifies that monitoring shall also be conducted following a significant flow event, even if that flow event occurs more than two years following dam removal. Proposed Aquatic Resource Measure AR-1 also includes a spawning habitat evaluation on the Klamath River and tributaries in the Hydroelectric Reach. If spawning habitat conditions following dam removal do not meet target metrics[93] developed to offset the anticipated loss of Chinook salmon and steelhead redds due to the Proposed Project, spawning gravel augmentation would be completed within the mainstem, with additional spawning habitat actions within tributaries. Tributary spawning habitat restoration actions to be completed in Jenny Creek, Shovel Creek, Fall Creek, and/or Spencer Creek could include removal of artificial fish passage barriers, or placement of large woody debris to trap and retain spawning gravels. Mitigation Measure AQR-1 Mainstem Spawning further specifies the range of actions that shall be conducted in tributaries to offset impacts to EFH. Implementation of proposed Aquatic Resource Measure AR-1 and Mitigation Measure AQR-1 would reduce the short-term impacts of SSCs on Chinook and coho salmon EFH in dam removal year 2 by improving access to tributary habitat where impacts from SSC on habitat in the mainstem can be avoided, and by augmenting spawning gravel to ensure that an equivalent amount of spawning habitat is available following dam removal. Therefore, it is anticipated that, in the short term, fewer Chinook and coho salmon would spawn in the mainstem prior to and following the dam removal, and suitable spawning gravel access would be maintained.

Proposed Aquatic Resource Measure AR-2 includes three primary actions: (1) salvaging mainstem overwintering juvenile salmonids prior to reservoir drawdown; (2) maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River; and (3) developing a water quality monitoring network, trigger thresholds, and plan for salvaging and relocating juvenile fish from tributary confluence areas to cold water tributaries or nearby off-channel ponds. Implementation of proposed Aquatic Resource Measure AR-2 would reduce the short-term effects of SSCs on Chinook and coho salmon EFH in the mainstem during dam removal by actively transporting up to 500 juvenile coho salmon from vulnerable mainstem areas to off-channel ponds protected from the effects of the Proposed Project. Other native fish captured during the seining and trapping effort, such as juvenile Chinook salmon would also be relocated into tributary streams adjacent to the salvage locations, thus off-setting water quality impacts to Chinook and coho salmon EFH. In addition, proposed Aquatic Resource Measure AR-2 would reduce the short-term effects of SSCs to migratory Chinook and coho salmon EFH by rescuing and transporting smolts if mainstem SSC are high, and water quality conditions within tributaries are too poor to provide safe refuge (a decision to be made in regular consultation with the ATWG). Proposed Aquatic Resource Measure AR-2 would also reduce the potential short-term effects of SSCs to migratory habitat for Chinook and coho salmon smolts by maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River. Monitoring would occur regularly for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No.11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-2 Mainstem Spawning (described in detail in Potential Impact 3.3-1) further specifies that monitoring shall also be conducted following a 5-year flow event, even if that flow event occurs more than two years following dam removal. These actions would effectively reduce the number of salmon juveniles and smolts potentially exposed to periods of high SSC in the mainstem habitat following dam removal, and therefore reduce the proportion of the population experiencing sub-lethal effects or mortality in temporarily degraded habitat.

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93 Spawning gravel in the amount of 44,100 yd^2 for fall Chinook salmon and 4,700 yd^2 for steelhead

Based on the wide distribution and use of tributaries by both juvenile and adult Chinook and coho salmon, implementation of the KRRC's proposed aquatic resource measures (AR-1 and AR-2), and implementation of mitigation measures (AQR-1 and AQR-2) developed for this EIR (where both sets of measures were designed to offset short-term impacts to Chinook and coho salmon EFH), there would not be a substantial decrease in the quality of a large proportion of Chinook and coho salmon EFH in the short term. Therefore, the Proposed Project would have no significant impact on Chinook and coho salmon EFH in the short term.

In the long term, bedload supply and transport following dam removal would increase supply of gravel downstream from the dam as far downstream as Cottonwood Creek (see Appendix F). This would potentially improve EFH for Chinook and coho salmon by reducing median substrate to a size more favorable for spawning (USBR 2012). In the long term, the Proposed Project would also increase habitat for Chinook and coho salmon (upstream of currently designated EFH) by providing access to habitats upstream of Iron Gate Dam. EFH quality would be affected by improved water quality, and decreased prevalence of disease, as described above for coho salmon critical habitat. Improved access to habitats (upstream of currently designated EFH), improved water quality, increased sediment transport, and decreased prevalence of disease, would be beneficial to EFH for Chinook and coho salmon in the long term.

Significance

No significant impact with mitigation to Chinook and coho salmon EFH in the short term

Beneficial for Chinook and coho salmon EFH in the long term

Potential Impact 3.3-5 Effects on groundfish Essential Fish Habitat (EFH) quality due to short-term sediment releases and long-term changes in habitat quality due to dam removal.

EFH for Pacific Coast groundfish includes all waters and substrate within areas with a depth less than or equal to 3,500 meters (1,914 fathoms [ftm]) shoreward to the mean high-water level or the upriver extent of saltwater intrusion. Within the Area of Analysis for aquatic resources, this includes the Klamath River Estuary and Pacific Ocean nearshore environment.

In the short term, under the Proposed Project, impacts to the nearshore environment are not anticipated to be distinguishable from existing conditions, based on a relatively small magnitude of SSCs released to the nearshore environment, an anticipated rapid dilution of the sediment plume as it expands in the ocean, and a relatively low rate of deposition of sediments to the Pacific Ocean nearshore environment bottom substrates (Section 3.3.5.1 *Suspended Sediment*). EFH in the Klamath River Estuary could be affected by elevated SSCs for about four months during the winter following dam removal, during which time many groundfish species could be spawning. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks (potentially > 1,000 mg/L) downstream from Iron Gate Dam would still be substantial and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see Section 3.3.5.1 *Suspended Sediment*). However, increased suspended sediment is not anticipated to substantially decrease the quality of groundfish EFH, which is adapted to periodic pulses of high sediment. In addition, the area of EFH for groundfish affected by the Proposed Project within the Klamath River Estuary is a very small proportion (<1 percent) of the total EFH designated for groundfish along the Pacific Coast. Therefore, impacts to groundfish EFH from the Proposed Project would have no significant impact in the short term.

In the long term, SSCs would be similar to those under existing conditions. Water quality benefits resulting from the Proposed Project would largely have dissipated upstream of the estuary, and therefore, water quality in the estuary would be expected to remain similar to existing conditions. Therefore, there would no impact to groundfish EFH from the Proposed Project in the long term.

Significance

No significant impact to groundfish EFH in the short term

No significant impact to groundfish EFH in the long term

Potential Impact 3.3-6 Effects on pelagic fish Essential Fish Habitat (EFH) quality due to short-term sediment releases and long-term changes in habitat quality due to dam removal.

EFH for coastal pelagic species occurs from the shorelines of California, Oregon, and Washington westward to the exclusive economic zone and above the thermocline where sea surface temperatures range from 50 to 78.8°F. Within the Area of Analysis for aquatic resources, this includes the Pacific Ocean nearshore environment. Substantial dilution of the mainstem river SSCs is expected to occur in the nearshore under the Proposed Project, and therefore the SSCs in the nearshore ocean would be expected to be similar to what would occur during existing extreme conditions. Pelagic fish are highly adapted to periods of increased suspended sediment and have the ability to swim away from areas of temporary poor habitat quality. In addition, the area for EFH for pelagic fish affected by the Proposed Project within the near-shore environment is a very small proportion (less than one percent) of the total EFH designated for pelagic species along the Pacific Coast. Overall, there would be no substantial reduction in the quality of pelagic fish EFH, and thus there would be no significant impact to pelagic fish EFH from the Proposed Project in the short term or long term.

Significance

No significant impact to pelagic fish EFH in the short term

No significant impact to pelagic fish EFH in the long term

Potential Impact 3.3-7 Effects on the fall-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

The potential for the Proposed Project to significantly increase the salmonid population in the Klamath River, including the fall-run Chinook salmon population, is an underlying purpose for the Proposed Project (KHSA 2016, Appendix B: *Definite Plan*). Therefore, as described in Section 2.7 *Proposed Project*, the drawdown timing for J.C. Boyle, Copco No. 1, and Iron Gate reservoirs under the Proposed Project was selected to minimize impacts from sediment release following dam removal under the Proposed Project to aquatic species, including fall-run Chinook salmon. Based on the distribution and life-history timing of fall-run Chinook salmon in the Klamath Basin, only a portion of

Chinook salmon adults, juveniles, and smolts are likely to be present in the mainstem Klamath River during the periods of greatest sediment transport between January and March. Most individuals are in tributaries, or further downstream during this time where concentrations would be diluted by tributary inflows. Additionally, the timing of drawdown coincides with periods of naturally high suspended sediment in the Klamath River, to which fall-run Chinook salmon have adapted by avoiding and tolerating.

This potential impact section begins with a summary of the available analysis predicting the response of the fall-run Chinook salmon population to the Proposed Action in the short- and long-term. The section then discusses in detail the potential short-term and long-term changes from the Proposed Project in each of the five study reaches within the Area of Analysis.

Quantitative modeling of fall-run Chinook salmon populations predict that the Proposed Project would increase Chinook salmon abundance. Modeling of dam removal and existing conditions by Oosterhout (2005) suggests that dam removal would substantially increase Chinook full-run spawners over a 50-year period relative to other management scenarios. Additional population capacity and modeling efforts support this conclusion (Huntington 2006, Dunsmoor and Huntington 2006, Hendrix 2011, Lindley and Davis 2011). Of these, the Hendrix (2011) life-cycle model (Evaluation of Dam Removal and Restoration of Anadromy, EDRRA) approach is considered the most intensive and robust conducted to date, because it explicitly addressed the Proposed Project, used stock-recruitment data from the Klamath River, explicitly incorporated variability in watershed and ocean conditions, and presented variance estimates of uncertainty.

Hendrix (2011) applied EDRRA to forecast the abundance of Chinook salmon (Type I and Type II life history strategies) for both the Proposed Project and continuation of existing conditions for the years 2012 to 2061. The EDDRA model did not incorporate potential climate change effects. The EDRRA Chinook salmon life cycle model assumes that current management rules (fishery control rule) established by the Pacific Fishery Management Council (PFMC) for management of Klamath River Chinook salmon would remain in place throughout the 50-year period of analysis. The PFMC has regulatory jurisdiction over salmon fishing within the 317,690-square mile exclusive economic zone from three miles to 200 miles off the coast of Washington, Oregon, and California. Since the management of salmon considers many factors that can fluctuate greatly from year to year (population abundance and environmental conditions) it is impossible to predict how future management decisions regarding the specific harvest of Klamath Basin salmon might change as a result of the Proposed Project. As stated in Hendrix (2011) “this rule is based on an optimal (i.e., escapement that produces maximum sustainable yield) escapement target after harvest of 40,700 (PFMC 2005).” The analysis uses the same escapement target (40,700 fish) for both alternatives despite the fact that Klamath Basin spawning distribution would be extended by hundreds of miles under the Proposed Project (as described below) and would therefore presumably have a higher escapement target. Therefore, in the EDRRA model, harvest and escapement targets to sustain the population are being managed optimally under existing conditions, whereas under the Proposed Project the escapement target is likely lower than would be required to fill newly accessible habitat. If the PFMC changes management under the Proposed Project based on additional access to spawning and rearing habitat, the harvest and escapement targets could be higher than predicted by the EDRRA model.

The EDRRA model assumes a flow regime under the Proposed Project based on the 2010 BiOp flows (NMFS 2010a), and implicitly incorporates water quality and disease by modeling a smolt survival rate that varies based on flows. The model assumes habitat restoration actions in the Upper- and Mid-Klamath basins, and it further assumes that these actions would take time to become effective. This EIR's analysis selectively uses the EDRRA modeling results that characterize conditions prior to habitat restoration because habitat restoration in the Upper- and Mid-Klamath basins is not included as part of the Proposed Project (aside from habitat restoration in Lower Klamath Project reservoirs). The EDDRA model also assumes active reintroduction efforts described in Hooton and Smith (2008), which would fully seed available fry habitats upstream of Iron Gate Dam, including the Upper Klamath Basin upstream of Upper Klamath Lake, prior to dam removal. Active reintroduction of fall-run Chinook salmon is not currently planned following dam removal under the Proposed Project. Instead, natural volitional reintroduction is anticipated under the Proposed Project and would require a longer time to meet the production levels predicted by the EDRRA model and reported by Hendrix (2011).

The EDRRA model assumes that Iron Gate Hatchery production does not occur under the Proposed Project. Therefore, the eight years of hatchery releases of Chinook salmon, after Lower Klamath Project dams removal, albeit at reduced production goals compared with existing conditions (43 percent decrease in Chinook age 0 and age 1 smolt release goals compared with current releases), would somewhat offset the lack of active reintroduction included in the EDRRA model.

From 1978 through 2016, returns of fall-run Chinook salmon adults to the Iron Gate Hatchery have ranged from 2,558 (in 1980) to 72,474 (in 2001), and averaged 16,559 (CDFW 2016b). During the same period, natural returns in the Klamath River (excluding Trinity River returns) ranged from 6,957 to 91,757 fall-run Chinook salmon, with an average of 31,379 fish (CDFW 2016a). While natural returns typically outnumber hatchery returns, the proportion of the Chinook salmon escapement composed of Iron Gate Hatchery returns has historically been substantial (approximately 35 percent of age 3 adults, KRTT 2011, 2013, 2015). Assuming a 43 percent decrease in smolt production relative to current (2005 through 2018) releases would result in a similar reduction in adult returns; it is possible that between post-dam removal years 3 and 10 (Table 3.3-11) an average of 7,120 fewer fish could return on an annual basis due to reduced hatchery releases. The elimination of the goal of releasing around six million Chinook salmon smolts and yearlings annually after eight years (post-dam removal year 7) would be anticipated to result in a reduction in adult hatchery returns to the Klamath River. Most adult returns are age 3 (around 75 percent), with some age 4 (around 23 percent), and a few age 5 (less than 2 percent) (KRTT 2011, 2013, 2015). As a result, progeny of hatchery releases are anticipated to return as adults continuing mostly through post-dam removal year 10 (four-year old returns, progeny of final releases in post-dam removal year 7). The first adult returns from the progeny of naturally spawning fall-run Chinook salmon in newly accessible habitat upstream of the location of Iron Gate Dam would be expected in post-dam removal year 3 (3-year old returns, progeny of post-dam removal year 1; Table 3.3-3). Therefore, between post-dam removal years 3 and 10, both hatchery returns and returns from newly accessible habitat would occur, potentially increasing the rate of reintroduction comparable to the effect of active reintroduction assumed in the EDRRA model. Impacts associated with hatcheries operations in relation to water diversions and minimum bypass flows for fish passage is discussed in

Potential Impact 3.3-23 (Iron Gate Hatchery) and Potential Impact 3.3-24 (Fall Creek Hatchery).

The amount of time required for the fall-run Chinook salmon population in the Klamath River to reach capacity under the Proposed Project would be a function of adult returns that volitionally recolonize new habitat, although there is no accurate means to predict how much longer it would take to reach full capacity without the active reintroduction modeled using EDRRA. Recolonization success and rate is a function of fish straying into newly available habitats (Pess 2009). For Chinook salmon, stray rates are around six percent (Hendry et al. 2004), and 95 percent of strays migrate less than 20 miles from their natal area (Quinn and Fresh 1984, Quinn et al. 1991). However, following major changes in environmental conditions (e.g., dam removal, high SSC), salmonid stray rates have been observed to increase. For example, Leider (1989) reported steelhead stray rates increasing from 16 percent to 45 percent during recolonization of streams following the Mt. Saint Helens eruption. The time period of colonization (historical or new habitat) has been reported to occur within five to thirty years, with most falling between one to two decades (Withler 1982, Bryant 1999, Burger et al 2000, Glen 2002, Pess et al. 2003, Milner et al. 2008, Kiffney et al. 2009). Rapid (less than one year) recolonization was observed for fall-run Chinook salmon following fish ladder installation at Landsburg Dam on the Cedar River, Washington (Kiffney et al. 2009) and within months of removal of Condit Dam on the White Salmon River, Washington (Allen et al. 2016). Fall-run Chinook salmon were observed to recolonize habitat upstream of the former location of the Elwha Dam within the first year of dam removal, and within five years of dam removal a majority of returning adults were spawning in newly accessible habitat upstream of the former dam location (Weinheimer et al. 2018). A ladder was placed on the Landsburg Dam in 2003, and Chinook salmon immediately (i.e., the first fall following ladder installation) accessed areas upstream of the dam, with juveniles of both species being observed during snorkel surveys the following year. By 2011, Chinook salmon occurred throughout nearly all accessible habitat upstream of the dam.

It is likely that following dam removal under the Proposed Project, recolonization of the 80 miles of habitat downstream of Keno Dam would be rapid, with a longer timeframe for habitat in the Upper Klamath River and connected waterbodies (and contingent on fish passage being provided at Keno Impoundment/Lake Ewauna). The EDRRA model prediction is that with dam removal there would be substantially more (median increase greater than 10,000) returning adult Chinook salmon in the Klamath Basin than without dam removal, where the prediction is based solely on access to habitat between Iron Gate and Keno dams.

Median escapements to the Klamath Basin are predicted to be higher (median increase greater than 30,000) with the Proposed Project than under existing conditions. The potential for ocean harvest is also predicted to be greater with the Proposed Project due to increased Chinook salmon adults in ocean, and the probability of low escapement leading to fishery closures was less under the Proposed Project. Modeling results of Hendrix (2011) indicated uncertainty in Chinook salmon stock recruitment dynamics due to the uncertainty in predicting smolt production based on habitat conditions, as well as uncertainty in escapement and harvest abundance forecasts based on habitat conditions. Despite the uncertainty, the results indicate that the Proposed Project would result in higher relative abundance of Chinook salmon.

In addition to the quantitative EDRRA modeling results, FERC (2007) and Hamilton et al. (2011) synthesized all available information and both concluded that increased habitat access following dam removal would result in an increase in the abundance of fall-run Chinook salmon population in the Klamath Basin.

Further, to help determine if the Proposed Project would advance restoration of the salmonid fisheries of the Klamath Basin, a Chinook Salmon Expert Panel was convened to attempt to answer specific questions that had been formulated by the KHSA (2016) stakeholders to assist with assessing the effects of the KHSA compared with existing conditions (Goodman et al. 2011). The Chinook Salmon Expert Panel concluded that Lower Klamath Project dam removal (and habitat restoration actions associated with the KBRA) would be a major step forward in conserving target fish populations in the Klamath Basin. The Chinook Salmon Expert Panel predicted that, based on the information provided to them, it was possible that Lower Klamath Project dam removal would provide a substantial increase in the abundance of naturally spawned Klamath River Chinook salmon above that expected under existing conditions in the reach between Iron Gate Dam and Keno Dam. In addition, the Chinook Salmon Expert Panel concluded that Lower Klamath Project dam removal offers greater potential than the existing conditions for Chinook salmon to tolerate climate change and changes in marine survival (Goodman et al. 2011). While the Chinook Salmon Expert Panel agreed that there was also evidence for potential dramatic increases in abundance associated with potential fish passage upstream of Keno Dam as well, they cautioned that achieving substantial gains in Chinook salmon abundance and distribution in the Klamath Basin is contingent upon successfully resolving key factors that would continue to affect the population, including water quality in Upper Klamath Lake and Keno Reservoir, disease, colonization of the Upper Klamath River Basin, harvest and escapement, hatchery interactions, predation by resident fish, climate change, instream flows, and impacts from dam removal. The anticipated influence of the Proposed Project on these factors (among others) within specific reaches is described below.

Upper Klamath River and Connected Waterbodies

As discussed above under 3.3.5.8 *Aquatic Habitat*, under the Proposed Project, removal of the Lower Klamath Project dams would allow fall-run Chinook salmon to regain access to around 360 miles within the upper Klamath River upstream of Upper Klamath Lake (DOI 2007, Hamilton et al. 2005, 2016). The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River, upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005, 2016). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive habitat upstream of Iron Gate Dam (DOI 2007), including access to groundwater-fed areas with relatively cold water that would be resistant to climate change-induced water temperature increases (Hamilton et al. 2011).

As discussed under Section 3.3.5.3 *Water Quality*, the Keno Impoundment/Lake Ewuana has the potential to be a habitat barrier during most years for fall-run Chinook due to poor water quality during the late summer, and therefore NMFS and USFWS have prescribed fish passage measures for the Keno Impoundment/Lake Ewuana to be used during periods of poor water quality (DOI 2007). If fish passage were not provided, fall-run Chinook salmon would be limited to the additional habitat access in the Hydroelectric Reach, as described in detail below. Over the long term, seasonal dissolved oxygen in the Keno Impoundment/Lake Ewauna would also be expected to improve as TMDL implementation projects continue. While it would be speculative at this point to identify the timing or scope of such improvements, it is reasonable to assume that the multiple water quality improvement projects would work to shorten the season of impairment in the reach (allowing early and/or later migrants to reach upstream spawning habitat) and to reduce the number of years in which Keno Impoundment/Lake Ewauna's poor water quality forms a barrier to migration.

Upper Klamath River - Hydroelectric Reach

The Proposed Project would restore fall-run Chinook salmon access to the Hydroelectric Reach, expanding their distribution to include historical habitat along the mainstem Klamath River and all tributaries upstream at least as far as Spencer Creek; including in Jenny, Shovel, and Fall creeks (Hamilton et al. 2005), totaling around 80 miles of potential habitat within the Hydroelectric Reach, including 21.2 miles of habitat currently inundated by Lower Klamath Project reservoirs (DOI 2007, Cunanan 2009). Historically, Chinook salmon (both fall- and spring-run) spawned and were abundant within this habitat (NMFS 2006a, Hamilton et al. 2016). Prior to construction of Iron Gate Dam, Coots and Wales (1952) observed about 300 Chinook salmon spawning in the Copco No. 2 Bypass Reach at around eight cfs, with additional spawning habitat available at the time of survey.

Adults would be able to access this reach starting in September of dam removal year 2 (Table 2.7-1). By fall of dam removal year 2, elevated SSCs from dam removal would have subsided (USBR 2012). Because of this, fall-run Chinook salmon would not be exposed to the elevated SSCs that would occur during dam removal in this reach. Most of the sediment stored within the river channels currently inundated by Lower Klamath Project reservoirs would likely be eroded by the end of spring of dam-removal year 2. The maximum deposition anticipated is minor (less than 0.5 foot), within pockets of the river reaches between reservoirs, settling into pool and other low-velocity habitats as water velocities decrease. This would constitute a negligible and temporary (less than six months following reservoir drawdown in dam removal year 1) reduction in the quality of habitat and would occur prior to the first adult salmon accessing newly available habitat in post-dam removal year 1.

River channel habitat within the reservoir reaches would be primarily low gradient habitat which is of critical importance for salmon spawning and rearing. For example, FERC (2007) described the Copco No. 2 bypassed reach and reaches inundated by Iron Gate and Copco reservoirs to be low gradient. For these reaches, they estimated that the density of Chinook salmon spawners per mile for mainstem habitat was twice that of high gradient habitat (FERC 2007). These river channels would likely excavate to their pre-dam elevations within six months, and revert to and maintain pool-riffle morphology due to restoration of riverine processes, creating holding, spawning, and rearing habitat for anadromous salmonids.

Modeling (USBR 2012) indicates that after dam removal, spawning gravel in all sections of the Hydroelectric Reach would be within the range usable for fall-run Chinook salmon, but the amount of sand in the bed within former reservoir sections could initially inhibit spawning success. The bed material within the reservoirs and from Iron Gate Dam to Cottonwood Creek is expected to have a high content (30 to 50 percent) of sand immediately following reservoir drawdown until a flushing flow moves the sand sized material out of the reach (USBR 2012). The flushing flow is expected to be at least 6,000 cfs and of several days to weeks to return the bed to a bed dominated by cobble and gravel with a sand content less than 20 percent. After the flushing flow, the bed is expected to maintain fractions of sand, gravel, and cobble which would be expected under natural conditions. Based on the historical record a sufficient flushing flow would likely occur within five years following dam removal (see Section 3.6.5.1 *Flood Hydrology*).

Habitat currently within inundated Lower Klamath Project reservoir that would be exposed following dam removal under the Proposed Project is anticipated to be used during the first spawning migration after dam removal (fall of dam removal year 2). A similar rapid recolonization of formally reservoir inundated habitat was observed at two dam removal sites in southern Oregon. Following removal of Savage Rapids Dam on the Rogue River in 2009, 91 redds from within the bounds of the former reservoir were documented where no redds had existed previously in 2010 (the first fall spawning season following dam removal), and more the following year (ODFW 2011). Following removal of the Gold Ray Dam on the Rogue River in 2010, 37 redds were documented from within the bounds of the former reservoir the fall after dam removal, with over twice that many the following year (ODFW 2011).

The Proposed Project would establish flow and water quality conditions that more closely mimics natural conditions by incorporating more variability in daily flows (described in Section 3.6.5.1 *Flood Hydrology*). The reservoir drawdowns would also allow tributaries and springs such as Fall, Shovel, and Spencer creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011).

In addition, as described in detail in Section 3.3.5.5 *Fish Disease and Parasites*, it is unlikely that the disease conditions that currently exist downstream of Iron Gate Dam would develop upstream of Iron Gate Dam under the Proposed Project.

Middle and Lower Klamath River

In the short term in this reach, the Proposed Project would decrease dissolved oxygen and release dam-stored sediment downstream to the Lower Klamath River. In the long term, the Proposed Project would restore a flow and sediment regime that more closely mimics natural conditions in the long term. Suspended sediment effects on fall-run Chinook salmon under the Proposed Project are described in detail in Appendix E.3.2.1, and summarized here.

During the fall and winter of dam removal year 1, under the least impacts on fish, most-likely impacts on fish, or worst impacts on fish scenario, no impact from suspended sediment is anticipated for all adult fall-run Chinook salmon migrating or spawning within tributaries to the Klamath River, or for juveniles rearing within tributaries (Appendix E, Table E-8). Under the most-likely impacts on fish or worst impacts on fish scenario, complete loss of eggs from the dam removal year 1 brood year deposited in the mainstem in fall of dam removal year 1 is predicted. Based on redd surveys from 1999 through 2009 (Magneson and Wright 2010), an average of around 2,100 redds could be affected in the mainstem. As described in detail in Appendix E.3.2.1, based on escapement estimates in the Klamath Basin from 2001 through 2009 (CDFG 2010, unpublished data) on average this would be around eight percent of all anticipated fall-run Chinook salmon redds in the Klamath River Basin in the fall spawning of dam removal year 1.

In dam removal year 2 suspended sediment could be high enough for long enough duration to cause moderate physiological stress for returning adults during the fall under a least impacts on fish scenario, impaired homing under a most-likely impacts on fish scenario, and major physiological stress under the worst impacts on fish scenario (Appendix E.3.2.1). For smolts, in dam removal year 2 suspended sediment is anticipated to have sublethal effects on Type I, Type II, and Type III outmigrants (Appendix E.3.2.1) and would not cause substantial reductions in abundance. The Type I smolts affected by increased SSCs during dam removal year 2 would be the progeny of the same cohort[94] of adult spawners potentially affected by dam removal. However, the Type-II and Type-III progeny of that same cohort of adults that successfully spawn in tributaries during dam removal year 2 would produce smolts that would outmigrate to the ocean a year after the spring pulse of suspended sediment in dam removal year 2 and should not be noticeably affected by the Proposed Project.

In the long term (by post-dam removal year 2), SSC in the Middle and Lower Klamath River are predicted to return to similar levels to existing conditions, and no substantial effect on fall-run Chinook salmon is anticipated.

In the short term, a higher proportion of sand in the mainstem channel bed surface may reduce the quality of spawning habitat in the mainstem Klamath River downstream of Iron Gate Dam. As described in detail in Appendix F, the dam removal year 2 fall-run Chinook salmon cohort could be affected by sediment deposits with higher levels of sand than under existing conditions. After a flushing flow of at least 6,000 cfs, the bed is expected to maintain fractions of sand, gravel, and cobble which would be expected under natural conditions, and suitable for fall-run Chinook salmon. Based on the historical record a sufficient flushing flow would likely occur within five years following dam removal. These effects would be most apparent in successive median or dry years following dam removal, but less apparent in successive wet years (Appendix F). Increased proportion of sand in the spawning substrate could reduce embryo survival-to-emergence (Chapman 1988) for fall-run Chinook salmon spawning during fall of dam removal year 1 (affecting fry that would emerge and smolt during dam removal year 2). Changes in bedload would be limited to the reach from Iron Gate Dam to Cottonwood Creek, a length of eight miles, or 4 percent of the channel length of the mainstem Klamath River downstream from Iron Gate Dam. The most severe effects would also be limited to a small proportion of the total channel length (0.5 miles, or less than one percent of the channel downstream from Iron Gate Dam), as sediment deposition would lessen downstream from Bogus Creek to Cottonwood Creek. At most, around eight percent of fall-run Chinook salmon in the Klamath Basin are expected to spawn in the mainstem downstream of Iron Gate Dam prior to dam removal, with an even smaller percentage expected to spawn within the 8-mile affected reach (described in Appendix E.3.2.1).

In the long term, the river would eventually exhibit enhanced habitat complexity due to increased sediment supply, a more natural flow regime, greater sediment transport rates, and more frequent bed mobilization that would increase spawning habitat availability and quality and improve early rearing habitat downstream from Iron Gate

[94] Cohort is a group of fish born during the same year.

Dam (see Appendix F). Bedload sediment movement and transport are vital to create and maintain functional aquatic habitat. An increased supply of gravel from upstream sources is predicted to improve spawning gravel quality and increase the amount of fall-run Chinook salmon spawning habitat downstream from Iron Gate Dam by decreasing the median substrate size to 1.5 to 2.4 in (USBR 2012), within the observed range for Chinook salmon spawning (0.6 to 2.8 in [Kondolf and Wolman 1993]). Pools would likely return to their pre-sediment release depth within one year (USBR 2012), and the river is predicted to revert to and maintain a pool-riffle morphology providing suitable habitat for fall-run Chinook salmon.

Short-term (less than two months) reductions in dissolved oxygen are anticipated to occur as a result of high organic SSCs following dam removal, as described in detail in Potential Impact 3.2-9. Despite predicted short-term increases in oxygen demand under the Proposed Project, dissolved oxygen concentrations would generally remain above the minimum acceptable level (5 mg/L) for salmonids of all life stages in this reach. Exceptions to this would occur four to eight weeks following drawdown of J.C. Boyle and Iron Gate reservoirs (i.e., in February dam removal year 2), when dissolved oxygen would remain below 5 mg/L for a distance approximately 48–71 miles downstream from Iron Gate Dam (approximately RM 145 to RM 122). Any incubating fall-Chinook salmon eggs in the river during this time are assumed to have already suffered 100 percent mortality caused by increased SSC during this time, and thus the decrease in dissolved oxygen is not anticipated to have an additional effect. No other life-stages are anticipated to occur in the mainstem Klamath River during this time, and thus no additional effects are expected.

By eliminating peaking flows in the Hydroelectric Reach and removing the Lower Klamath Project reservoirs, the Proposed Project would support a flow regime that more closely mimics natural conditions in the Lower Klamath River. Flows under the Proposed Project are intended to benefit fall-run Chinook salmon and are anticipated to have positive consequences for Chinook salmon given their life cycle in the Klamath River.

As discussed in detail in Section 3.2.5.1 *Water Temperature*, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall and have diurnal variations more synchronized with historical migration and spawning periods (Hamilton et al. 2011). Under the Proposed Project, warmer springtime temperatures would result in fall-run Chinook salmon fry emerging earlier (Sykes et al. 2009), encountering favorable temperatures for growth sooner than under existing conditions (Figure 3.3-5), which could support higher growth rates and encourage earlier migration downstream, thereby reducing stress and disease (Bartholow et al. 2005, FERC 2007). A predicted earlier outmigration in response to elevated water temperatures in the spring is also supported by the scientific literature relating to increased growth rates and thermal response of outmigrating salmonids, as summarized by Hoar (1988). In addition, fall-run Chinook salmon spawning in the mainstem during fall would no longer be delayed by water temperatures (reducing prespawn mortality) (Figure 3.3-4), and adult migration would occur in lower water temperatures than under existing conditions (Figure 3.3-5). Overall, these changes would result in water temperatures more favorable for fall-run Chinook salmon in the mainstem Klamath River downstream from Iron Gate Dam.

As described in Section 3.3.5.5 *Fish Disease and Parasites*, the Proposed Project is expected to disrupt many of the existing congruence of factors that lead to high disease parasite concentrations at locations with multiple water quality stressors for fish and resulting high levels of fish disease.

As described in Section 3.3.5.6 *Fish Hatcheries*, operation of the Iron Gate Hatchery and Fall Creek Hatchery, at a combined reduced capacity for eight years following dam removal, would be likely to reduce hatchery Chinook salmon returns available for ocean or in-river harvest compared with existing conditions. However, naturally-spawning adult returns benefiting from dam removal are predicted to occur beginning in post-dam removal year 3 and the larger returns would begin to offset reductions due to lower hatchery capacity during the first eight years following dam removal and, ultimately, to hatchery closure in post-dam removal year 7.

Also, as described in Section 3.3.5.6 *Fish Hatcheries*, the cessation of juvenile fish releases from Iron Gate Hatchery after eight years may also significantly decrease the amount of competition for food resources and habitat space between hatchery-reared and natural origin smolts and yearlings in the Klamath River. This would result in higher growth rates for natural origin fish (McMichael et al. 1997), and thus larger size at ocean entry beginning in post-dam removal year 8 (first year of no hatchery releases; Table 3.3-11). Smolt size is correlated with increased marine survival for Chinook salmon (Scheuerell et al. 2009, Feldhaus et al. 2016) which, in conjunction with reduced competition with hatchery smolts in the marine environment (Sweeting et al. 2003), is anticipated to result in increased adult returns as soon as post-dam removal year 10 (three-year-old adult returns). In addition, incidences of disease are expected to be reduced by ending hatchery operations after eight years.

Klamath River Estuary and Pacific Ocean Nearshore Environment
Under the Proposed Project, habitat in the Klamath River Estuary and the Pacific Ocean nearshore environment could be affected by sediment releases during dam removal for approximately three months (January through March) under all scenarios. After this time, SSCs would return to levels similar to existing conditions (see Appendix E). SSCs in the Klamath River Estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see Section 3.2.5.2 *Suspended Sediments*). However, the increased SSCs predicted to occur in the estuary would not be of sufficient magnitude or duration to result in substantial sublethal or lethal effects on fall-run Chinook salmon individuals (Appendix E.3.2.1). While the magnitude of SSCs released to the Pacific Ocean nearshore environment would be within the range of natural conditions, the duration of elevated SSCs (i.e., weeks) would be greater than would occur under natural (i.e., storm) conditions (i.e., days). Therefore, there also would be elevated SSCs in the Pacific Ocean nearshore environment relative to existing conditions (see Section 3.2.5.2 *Suspended Sediments*). However, no Chinook salmon adults or juveniles are anticipated to occur within the nearshore environment during this period.

Summary
In the short term, reservoir drawdown under the Proposed Project would result in elevated SSCs, low dissolved oxygen, and altered sand and finer bedload sediment transport and deposition, and would adversely impact fall-run Chinook salmon primarily

in the Middle Klamath River downstream of Iron Gate Dam. Fall-run Chinook salmon use the mainstem Klamath River for spawning, rearing, and as a migratory corridor. Direct mortality is predicted for a proportion of fall-run Chinook salmon redds. However, the effect of SSCs from the Proposed Project on the fall-run Chinook salmon population, under all scenarios, is not expected to substantially reduce the population because of variable life histories, the timing of SSC pulses to avoid the most vulnerable fall-run Chinook life stages, the comparatively small number of fall-run Chinook salmon that spawn in the mainstem, the large majority of age 0 juveniles that remain in tributaries until later in the spring and summer, and because many of the fry that outmigrate to the mainstem come from lower-Basin tributaries (e.g., Salmon and Trinity rivers) and thus would be subject only to conditions in the Lower Klamath River, where SSCs resulting from the Proposed Project are expected to be lower due to dilution from tributaries (USBR 2012). Based on no predicted substantial short-term decrease in fall-run Chinook salmon abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to fall-run Chinook salmon under the Proposed Project in the short term.

Although this EIR finds no significant impact on fall-run Chinook salmon In the short term, the KRRC proposes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including fall-run Chinook salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the less than significant short-term effects of the Proposed Project on fall-run Chinook salmon by increasing certainty regarding the effectiveness of the KRRC's proposed aquatic resource measures. Aquatic resource measures are summarized in Section 2.7.8.1 *Aquatic Resource Measures* and detailed in Appendix B: *Definite Plan − Appendix I*. Proposed Aquatic Resource Measure AR-1 includes the development and implementation of a monitoring and adaptive management plan to offset the impacts of Lower Klamath Project dam removal on mainstem spawning. Proposed Aquatic Resource Measure AR-1 actions include a 2-year tributary confluence monitoring effort and addressing sediment and debris obstructions that block volitional upstream passage from the Klamath River into tributaries. Monitoring would occur regularly for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No. 11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-1 Mainstem Spawning (detailed above), developed for this EIR, further specifies that monitoring shall also be conducted following a significant flow event, even if that flow event occurs more than two years following dam removal. Proposed Aquatic Resource Measure AR-1 also includes a spawning habitat evaluation on the Klamath River and tributaries in the Hydroelectric Reach. The spawning habitat actions of AR-1 are focused on offsetting impacts of the Proposed Project on Chinook salmon and steelhead. If spawning habitat conditions following dam removal do not meet target metrics[95] developed to offset the anticipated loss of Chinook salmon and steelhead redds due to the Proposed Project, spawning gravel augmentation would be

[95] Spawning gravel in the amount of 44,100 yd^2 for fall Chinook salmon and 4,700 yd^2 for steelhead

completed within the mainstem, with additional spawning habitat actions within tributaries. Tributary spawning habitat restoration actions to be completed in Jenny Creek, Shovel Creek, Fall Creek, and/or Spencer Creek could include removal of artificial fish passage barriers, or placement of large woody debris to trap and retain spawning gravels. Mitigation Measure AQR-1 Mainstem Spawning (detailed above) further specifies the range of actions that shall be conducted in tributaries to offset impacts to Chinook salmon spawning. Proposed Aquatic Resource Measure AR-1 and Mitigation Measure AQR-1 would reduce the less than significant short-term impacts of SSCs on fall-run Chinook salmon spawning in dam removal year 1 by improving access to tributary habitat where impacts from SSCs in the mainstem can be avoided, and by augmenting spawning gravel ensuring that suitable spawning habitat in mainstem and tributaries is available following dam removal.

Proposed Aquatic Resource Measure AR-2 includes three primary actions: (1) salvaging mainstem overwintering juvenile salmonids prior to reservoir drawdown; (2) maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River; and (3) developing a water quality monitoring network, trigger thresholds, and plan for salvaging and relocating juvenile fish from tributary confluence areas to cold water tributaries or nearby off-channel ponds. Implementation of proposed Aquatic Resource Measure AR-2 would reduce the short-term effects of SSCs to fall-run Chinook salmon juveniles rearing in the mainstem during dam removal by actively transporting juveniles from vulnerable mainstem areas to off-channel ponds protected from the effects of the Proposed Project, thus offsetting water quality impacts to juvenile Chinook salmon. Seining efforts would be focused on coho salmon, but all captured juvenile Chinook salmon would also be relocated into tributary streams adjacent to the salvage locations. Proposed Aquatic Resource Measure AR-2 would also reduce the potential short-term effects of SSCs to fall-run Chinook salmon smolts by maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River. Monitoring would occur regularly for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No. 11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-2 Juvenile Outmigration (detailed below) developed for this EIR, further specifies that monitoring shall also be conducted following a significant flow event, even if that flow event occurs more than two years following dam removal. In addition, proposed Aquatic Resource Measure AR-2 would reduce the less than significant short-term effects of SSCs to migratory Chinook salmon smolts by rescuing and transporting smolts if mainstem SSC are high, and water temperatures within tributaries are too poor to provide safe refuge (a decision to be made in regular consultation with the ATWG).

These actions would effectively reduce the number of fall-run Chinook salmon juveniles and smolts potentially exposed to periods of high SSC in the mainstem following dam removal, and therefore off-set short-term impacts to the proportion of the population experiencing sub-lethal effects or mortality.

In the long term, removal of the Lower Klamath Project dams under the Proposed Project would increase habitat availability, restore a more natural flow regime by eliminating peaking flows in the Hydroelectric Reach and removing the Lower Klamath Project reservoirs, restoring more natural seasonal water temperature variation, improve water quality, and reduce the likelihood of fish disease, all of which would be beneficial for fall-run Chinook salmon. As stated above, dam removal would also restore connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin and would create additional spawning and rearing habitat within the Hydroelectric Reach. It is anticipated that the Proposed Project would increase the abundance, productivity, population spatial structure, and genetic diversity of fall-run Chinook salmon in the Klamath Basin (Hendrix 2011). In general, free-flowing river conditions created by the Proposed Project would likely increase adult migration rate, decrease outmigrant delay, and increase adult escapement (Buchanan et al. 2011b). As discussed in detail above, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for salmonids in the mainstem. In addition, under the Proposed Project diminished disease conditions and improved water quality in the mainstem Klamath River would likely improve the survival of smolts outmigrating from tributaries downstream from Iron Gate Dam (e.g., Scott and Shasta rivers). Finally, the loss of hatchery production following the closure of Iron Gate Hatchery and Fall Creek Hatchery following eight years of operation is anticipated to be offset by the increase in natural production from habitat upstream of Iron Gate Dam. If fish passage is not provided a Keno Impoundment/Lake Ewuana, restored habitat access to the Hydroelectric Reach and the multiple benefits of the Proposed Project would be beneficial for fall-run Chinook salmon in the long term. If fish passage were provided (per DOI [2007] fish passage prescriptions), an even greater magnitude of restored habitat access to the Upper Klamath River Basin and the multiple benefits of the Proposed Project would be beneficial for fall-run Chinook salmon in the long term.

Significance

No significant impact for fall-run Chinook salmon populations in the short term

Beneficial for fall-run Chinook salmon populations in the long term

Potential Impact 3.3-8 Effects on the spring-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

As discussed above for fall-run Chinook salmon, a Chinook Salmon Expert Panel was convened to attempt to answer specific questions that had been formulated by the project stakeholders to assist with assessing the effects of the Proposed Project compared with existing conditions (Goodman et al. 2011). While noting uncertainties based on existing data, the panel concluded that the prospects for the Proposed Project to provide a substantial positive effect for spring-run Chinook salmon were less certain than for fall-run Chinook salmon. The primary concern of the panel was that low abundance and productivity (return per spawner) of spring-run Chinook salmon could limit recolonization of habitats upstream of Iron Gate Dam.

There are a few basic mechanisms by which spring-run Chinook salmon could recolonize newly accessible habitat, including (1) straying of adults returning to the Salmon River, (2) adaptation of fall-run Chinook salmon to an early spring-run Chinook salmon life history, or (3) active reintroduction of spring-run Chinook salmon from another population. There are many examples of fall-run Chinook salmon rapidly recolonizing newly accessible habitat discussed in Potential Impact 3.3-7 above, and spring-run Chinook salmon were observed recolonizing habitat in the White Salmon

River, Washington, following removal of Condit Dam (Allen et al. 2016). Following the removal of Condit Dam most of the observed spring-run Chinook salmon spawning was upstream of the location of the former Condit Dam. The current spring-run Chinook salmon abundance in the Salmon River is low (Table 3.3-10), and the rate of recolonization could be slow as a result. However, under the Proposed Project water temperatures and instream flows in the Klamath River upstream of the confluence with the Salmon River are predicted to mimic more natural conditions, which could encourage increased straying into upstream habitat.

The potential for adaptation of fall-run Chinook salmon to a spring-run Chinook salmon life history was assessed by Thompson et al. (2018), and they concluded that based on the genetics of the fall-run Chinook salmon currently downstream of Iron Gate Dam, it was unlikely that this would occur. Active reintroduction of Chinook salmon with genetics suited to adapt to an early spring-run Chinook salmon life history may be successful strategy for recolonization (Thompson et al. 2018). The Proposed Project does not include an active reintroduction plan, although ODFW has been considering implementing active reintroduction of spring-run Chinook salmon following dam removal (T. Wise, ODFW, pers. comm., 2018).

Under the Proposed Project, steelhead, coho, and fall-run Chinook salmon yearlings and smolts would no longer be released from hatcheries in the Klamath River following post-dam removal year 7. Currently there are no releases of spring-run Chinook salmon from hatcheries into the Klamath River. Therefore, the closure of hatcheries eight years following dam removal is not anticipated to result in a decline in adult returns for spring-run Chinook. Impacts associated with hatcheries operations in relation to water diversions and minimum bypass flows for fish passage is discussed in Potential Impact 3.3-23 (Iron Gate Hatchery) and Potential Impact 3.3-24 (Fall Creek Hatchery).

The expected influence of the Proposed Project within specific reaches is described below.

Upper Klamath River and Connected Waterbodies

The Proposed Project would not result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins in this reach. Under the Proposed Project, dam removal would allow spring-run Chinook salmon to regain access to the Upper Klamath River upstream of J.C. Boyle Reservoir (FERC 2007). The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River and upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive habitat (DOI 2007), including access to important thermal refugia within areas influenced by groundwater exchange that are more resistant to climate change (Hamilton et al. 2011). Some of these areas, such as the lower Williamson River, have habitat that would provide substantial holding areas for spring-run Chinook salmon (Hamilton et al. 2011). Other holding areas with suitable temperatures upstream of J.C. Boyle Reservoir include groundwater influenced areas on the west side of Upper Klamath Lake, and the Wood River (Gannett et al. 2007). Warmer winter water temperatures associated with groundwater input to the river would also be conducive to the growth of salmonids (Hamilton et al. 2011).

Poor water quality (e.g., severe hypoxia, temperatures exceeding 77°F, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009, USGS 2010; both as cited in Hamilton et al. 2011). However, available information indicates that Upper Klamath Lake habitat is presently suitable to support Chinook salmon for at least the period from October through May (Maule et al. 2009). Currently, adult spring-run Chinook migration takes place in approximately April through June. Historically, adult spring-run Chinook salmon migrated upstream of the current location of Iron Gate Dam perhaps as early as February and March (Fortune et al. 1966) and likely held over in large holding pools in the mainstem in tributaries fed by cool water, and in thermal refuge habitat upstream of Upper Klamath Lake (Snyder 1931, CDFG 1990c, Moyle 2002). One benefit of such early migration (similar to the spring-run Chinook salmon migration timing currently observed in the Klamath Basin) would be the avoidance of periods of poor water quality in the vicinity of Keno Impoundment/Lake Ewuana. The restored water temperature regime under the Proposed Project may restore the natural upstream migration timing of adult spring-run Chinook salmon because of the shift in water temperatures downstream from Iron Gate Dam (Bartholow et al. 2005). Either under the current migration timing or under a shift towards earlier migration, most or all of the spring-run Chinook salmon migrants would be able to pass upstream through the Keno Impoundment/Lake Ewuana area before seasonal water quality reductions would make passage restricted.

Huntington (2006) reasoned that spring-run Chinook salmon likely accounted for the majority of the Upper Klamath Basin's actual salmon production under historical conditions. Huntington (2006) cautioned that while access to the Upper Klamath Basin provides considerable promise of increasing spring-run abundance, the existing potential for Chinook salmon production within the basin upstream of Upper Klamath Lake is clearly much lower than his estimate of historical potential. However, Huntington (2006) did not fully account for the historical (and unknown) production potential of Upper Klamath Lake itself, which could have been considerable, as suggested by a recent experimental reintroduction into Upper Klamath Lake (Maule et al. 2009).

Upper Klamath River - Hydroelectric Reach

The Proposed Project would restore spring-run Chinook salmon access to the Hydroelectric Reach, including include historical habitat along the mainstem Klamath River and all tributaries upstream at least as far as Spencer Creek; including in Jenny, Shovel, and Fall creeks (Hamilton et al. 2005), comprising around 80 miles of potential habitat within the Hydroelectric Reach (DOI 2007, Cunanan 2009). Chinook salmon (both fall- and spring-run) historically spawned and were abundant within this habitat (NMFS 2006a, Hamilton et al. 2016). Adults would be able to access this reach beginning in spring of dam removal year 2 (Table 2.7-1); thus, short-term gains in flow-related habitat or habitat expansion may be limited to later cohorts. Elevated SSCs and bedload movement from dam removal may not have sufficiently dissipated in time for the first potential migrants, but by the second adult migrant season in post-dam removal year 1, would return to background levels similar to those under existing conditions and would not be expected to affect spring-run Chinook salmon using this area. Adult spring-run Chinook salmon do not currently occur upstream of the Salmon River, and would not be expected to be able to use the mainstem Klamath River upstream of Iron Gate Dam until conditions in the Hydroelectric Reach are suitable.

The Proposed Project would establish flow and water quality conditions that more closely mimics natural conditions by eliminating peaking flows, removing Lower Klamath

Project reservoirs, and incorporating more variability in daily flows. The removal of the reservoirs would allow Fall, Shovel, and Spencer creeks to flow directly into the mainstem Klamath River, along with Big Springs (in the J.C. Boyle Bypass Reach) and additional springs, which would provide fish with patches of cooler water as refugia during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011).

As described in detail in Section 3.3.5.5 *Fish Disease and Parasites*, it is unlikely that the disease conditions that currently exist downstream of Iron Gate Dam would develop upstream of Iron Gate Dam under the Proposed Project.

Middle and Lower Klamath River

The Proposed Project would release dam-stored sediment downstream to the Lower Klamath River Reach in the short term and would establish a flow and sediment regime that more closely mimics natural conditions in the Middle Klamath River in the long term.

Short-term effects of elevated SSCs on spring-run Chinook salmon under the Proposed Project are described in detail in Appendix E.3.2.2 and summarized here. Spring-run Chinook salmon are primarily distributed in the Salmon River and other tributaries downstream with limits their exposure to temporarily elevated concentrations of suspended sediment that would occur in the mainstem Klamath River under the Proposed Project. Under all scenarios, no impact from suspended sediment is anticipated for all spring-run Chinook salmon spawning and rearing, which occurs primarily within tributaries (Table E-9). Suspended sediment is anticipated to have sublethal effects on adult migration, primarily for those adults returning to the Salmon River (around five percent of all spring-run migrants). All outmigrating spring-run Chinook salmon smolts enter the Klamath River at the confluence with the Salmon River, where SSC are predicted to be much lower than further upstream, and where SSCs under existing conditions can be high from tributary contributions of suspended sediment. Therefore, only sublethal effects on outmigrants are predicted (Appendix E, Table E-9), which is similar to existing conditions (Appendix E, Table E-3).

Short- and long-term changes in channel bed elevations and grain size in response to increased bedload supply would be limited to the reach from Iron Gate Dam to Cottonwood Creek, a length of eight miles, or four percent of the mainstem Klamath River channel downstream from Iron Gate Dam (see Appendix F for details). The most severe effects would also be limited to a small proportion of the total channel length (0.5 miles, or less than one percent of the channel downstream from Iron Gate Dam), as sediment deposition would lessen downstream from Bogus Creek to Cottonwood Creek and, thus, would not affect the area currently used by spring-run Chinook salmon. Within one year (i.e., by spring of post-dam removal year 1), SSCs would have returned to existing conditions and the channel would likely have reverted to its previous pool-riffle morphology (Stillwater Sciences 2008).

By eliminating peaking flows in the Hydroelectric Reach and removing the Lower Klamath Project reservoirs, the Proposed Project would support a flow regime that more closely mimics natural conditions in the Lower Klamath River, mostly upstream of the confluence of Scott Creek. Dam removal would cause water temperatures upstream of the Salmon River confluence to warm earlier in the spring and early summer and cool earlier in the late summer and fall and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperatures that are more favorable for salmonids in the mainstem upstream of the Salmon River confluence (Section 3.3.5.4 *Water Temperature*). Therefore, in the long term it is anticipated that improved mainstem migration conditions may increase migration of spring-run Chinook salmon upstream of the Salmon River towards newly accessible habitat.

Although disease incidence is predicted to decrease (resulting in increased salmonid smolt survival) under the Proposed Project (see Section 3.3.5.5 *Fish Disease*), these benefits would be most noticeable upstream of the confluence with the Salmon River, and thus are anticipated to have less of benefit for spring-run Chinook salmon than other salmonids in comparison with existing conditions.

Klamath River Estuary and Pacific Ocean Nearshore Environment

Under the Proposed Project, habitat in the Klamath River Estuary could be affected by elevated sediment releases during dam removal for about three months (January through March) when spring-run Chinook salmon smolts could be within the estuary (see Section 3.3.5.1 *Suspended Sediment* and Appendix E). After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project* and Appendix E). However, the increased SSCs predicted to occur in the Klamath River Estuary would not be of sufficient magnitude or duration to result in substantial sublethal or lethal effects on spring-run Chinook salmon individuals (Appendix E.3.2.2). While the magnitude of SSCs released to the Pacific Ocean nearshore environment would be within the range of natural conditions, the duration of elevated SSCs (i.e., weeks) would be greater than would occur under natural (i.e., storm) conditions (i.e., days). Therefore, there also would be elevated SSCs in the Pacific Ocean nearshore environment relative to existing conditions (see Section 3.2.5.2 *Suspended Sediments*). However, no Chinook salmon adults or juveniles are anticipated to occur within the nearshore environment during this period.

Summary

In the short term, reservoir drawdown associated with dam removal under the Proposed Project would alter SSCs and bedload sediment transport and bedload deposition. The overall effect of suspended sediment from the Proposed Project on the spring-run Chinook salmon population is not anticipated to differ substantially from existing conditions. Suspended sediment conditions experienced by adult migrants would result in minor and only sublethal impacts. No impacts are anticipated for the spawning, incubation, and fry stages because they do not occur in the mainstem. Type I, II, and III outmigrants are expected to experience similar conditions under the Proposed Project as under existing conditions. Based on no predicted substantial short-term decrease in spring-run Chinook salmon abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to spring-run Chinook salmon under the Proposed Project in the short term.

Although this EIR finds no significant impact on spring-run Chinook salmon In the short term, the KRRC proposes Aquatic Resource Measures AR-2 (Juvenile Outmigration) which would further reduce the potential for short-term effects of SSCs on salmonid juveniles and smolts, including spring-run Chinook salmon. In addition, although CEQA

Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, Mitigation Measure AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term, less than significant effects of the Proposed Project on spring-run Chinook salmon by increasing certainty regarding the effectiveness of the KRRC's proposed aquatic resource measure.

Aquatic resource measures are summarized in Section 2.7.8.1 and detailed in Appendix B: *Definite Plan − Appendix I*. AR-2 includes three primary actions: (1) salvaging mainstem overwintering juvenile salmonids prior to reservoir drawdown; (2) maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River; and (3) developing a water quality monitoring network, trigger thresholds, and plan for salvaging and relocating juvenile fish from tributary confluence areas to cold water tributaries or nearby off-channel ponds. Implementation of AR-2 would reduce the short-term effects of SSCs to outmigrating juvenile spring-run Chinook salmon smolts by rescuing and transporting smolts if mainstem SSC are high, and water quality conditions within tributaries do not allow safe refuge. This action would effectively reduce the number of spring-run Chinook salmon smolts potentially exposed to periods of high SSC in the mainstem following dam removal, and therefore reduce the proportion of the population experiencing sub-lethal effects.

In the long term, removal of the Lower Klamath Project dams under the Proposed Project would increase habitat availability, restore a more natural temperature regime, improve water quality, and reduce the likelihood of fish disease, all of which would be beneficial for spring-run Chinook salmon. Dam removal would restore connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin, including additional habitat within the Hydroelectric Reach. Access to additional habitat would provide a long-term benefit to spring-run Chinook salmon populations. The expansion of habitat opportunities would allow increased expression of life-history variation and the restoration of an additional population of spring-run Chinook salmon to strengthen resiliency in the Klamath Basin, particularly because passage upstream of Iron Gate Dam would provide access to groundwater-fed thermal refugia during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). By providing an unimpeded migration corridor, the Proposed Project would provide the greatest possible benefit related to fish passage, hence, the highest survival and reproductive success (Buchanan et al. 2011b). As discussed in detail above, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods in the mainstem upstream of the confluence with the Salmon River (Hamilton et al. 2011). These changes would result in water temperatures more favorable for spring-run Chinook salmon in the mainstem, supporting any portion of the population that recolonizes Klamath River Basin habitat upstream of the Salmon River. It is anticipated that, as a result of the Proposed Project, the spring-run Chinook salmon population within the Klamath Basin would have an opportunity to increase in abundance, and would have increased productivity, population spatial structure, and genetic diversity. Implementation of the Proposed Project would be beneficial for spring-run Chinook salmon in the long term.

Significance

No significant impact for spring-run Chinook salmon populations in the short term

Beneficial for spring-run Chinook salmon populations in the long term

Potential Impact 3.3-9 Effects on coho salmon populations due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

The Coho Salmon and Steelhead Expert Panel was convened and charged with answering specific questions that had been formulated to assist with assessing the effects of the Proposed Project on coho salmon (Dunne et al. 2011). While noting the constraints of the Coho Salmon and Steelhead Expert Panel to arrive at conclusions within a short time, and without adequate quantitative or synthesized information, the conclusion of the Coho Salmon and Steelhead Expert Panel was that, in the short term, the difference between the Proposed Project and existing conditions is expected to be small. The Coho Salmon and Steelhead Expert Panel stated that larger (moderate) increases in abundance are possible under the Proposed Project if additional restoration actions are implemented, and mortality caused by the pathogen *C. shasta* is reduced. The Coho Salmon and Steelhead Expert Panel predicted a small increase in the population from a modest increase in habitat area usable by coho salmon, small changes in conditions in the mainstem, and positive but un-quantified changes in tributary habitats where most coho spawn and rear. The Coho Salmon and Steelhead Expert Panel also noted the potential for increased disease risk and low ocean survival to offset gains in production in the new habitat, although no evidence for either increased disease risk or reduced ocean survival was presented.

Under the Proposed Project, hatchery coho salmon smolts would be released from Fall Creek Hatchery into the Klamath River at current (75,000 smolts annually) production goals for eight years following dam removal. During that eight-year period no change to the coho salmon population resulting from hatchery operations relative to existing conditions is anticipated. Eight years following dam removal, all hatchery coho salmon releases would cease (final releases would occur in dam removal year 7). Based on production goals, ceasing operations after eight years would likely result in a reduction of up to 75,000 coho salmon smolts per year beginning in post-dam removal year 8 (Table 3.3-11). Based on the current low abundance of coho salmon in the upper Klamath River population unit, a conservation focus for the coho salmon hatchery program has been deemed necessary to protect the remaining genetic resources of that population unit (CDFW 2014). Coho salmon adult returns to Iron Gate Hatchery have significantly and steadily declined from a high of 2,466 adults in the 2001/2002 return year to 38 in the 2015/2016 return year, with an average of 866 annually (CDFW 2016b). Assuming smolts are released for the last time in post-dam removal year 7, adults of hatchery progeny would continue to return through post-dam removal year 9 (as age 3 adults). Based on the average coho salmon smolt-to-adult survival ratio of 0.99 percent estimated for current coho salmon Iron Gate Hatchery operations (CDFW 2014), a reduction in the release of 75,000 coho salmon smolts following closure of Fall Creek Hatchery could result in a decline of around 743 adult returns on average annually starting in post-dam removal year 10. These adults would return to the Fall Creek Hatchery, but also stray and spawn naturally. Between 2004 and 2011 an average of 46 coho salmon hatchery adults per year strayed into Bogus Creek (CDFW 2014). Impacts associated with hatcheries operations in relation to water diversions and minimum bypass flows for fish passage is discussed in Potential Impact 3.3-23 (Iron Gate Hatchery) and Potential Impact 3.3-24 (Fall Creek Hatchery).

As described in Section 3.3.5.6 *Fish Hatcheries* and summarized in CDFW (2014), there are potential adverse hatchery-related effects on the coho salmon population, including straying of hatchery fish into important tributaries such as Bogus Creek (first three years) and Fall Creek (years four through ten) with the potential to reduce the reproductive success of the natural population (Mclean et al. 2003, Chilcote 2003, Araki et al. 2007) and negatively affect the diversity of the Klamath River coho salmon populations via outbreeding depression[96] (Reisenbichler and Rubin 1999). The current Hatchery Genetic Management Plan for Iron Gate Hatchery coho salmon (HGMP, CDFW 2014) operates to assist in the basin's coho salmon recovery efforts by conserving a full range of the existing genetic, phenotypic, behavioral, life history, and ecological diversity of the run. The intent of this program is to use genetic analysis in brood stock selection and rearing and release techniques improve fitness and reduce straying of hatchery fish to natural spawning areas.

Under the Proposed Project, dam removal and the associated habitat improvements are anticipated to result in an increase in coho salmon abundance. The first adults that could potentially access newly available habitat upstream of Iron Gate Dam would be in dam removal year 2 (Table 3.3-11) and produce age 1 smolts benefiting from improved river function (e.g., reduced disease in the Middle Klamath River). Therefore, the first adult returns that could reflect improved conditions would be in post-dam removal year 4 (as age 3 adults). Under existing conditions, CDFW (2014) estimates that greater than 30 percent of the total adult returns to the upper Klamath River are of hatchery origin, including greater than 70 percent of returns to the hatchery, around 34 percent of returns to Bogus Creek, and around 16 percent of returns to tributaries such as the Shasta and Scott rivers. Between post-dam removal years 4 and 10, both hatchery returns and returns from newly accessible habitat, would occur (Table 3.3-11) providing a likelihood of increased abundance and recolonization of the newly accessible habitat.

As described in Section 3.3.5.6 *Fish Hatcheries*, outmigrant smolt mortality from disease would be reduced under the Proposed Project starting in post-dam removal year 8 with the end of Chinook and coho salmon hatchery releases. The cessation of juvenile fish releases may also significantly decrease the amount of competition for food resources and habitat space between hatchery-reared and natural origin smolts in the Klamath River. This would result in higher growth rates for natural origin fish (McMichael et al. 1997), and thus larger size at ocean entry beginning in dam removal year 8. Smolt size is correlated with increased marine survival for coho salmon (Holtby et al. 1990), which in conjunction with reduced competition with hatchery smolts in the marine environment (Sweeting et al. 2003) is anticipated to result in increased adult returns as soon as post-dam removal year 10 (3-year-old adult returns). Although existing data are not available for a quantitative prediction, it is anticipated that benefits from dam removal and cessation of hatchery operations would increase adult returns by more than the loss of hatchery progeny.

Upper Klamath River and Connected Waterbodies

Available data suggests that coho salmon were in both mainstem and tributary reaches of the Klamath River upstream to and including Spencer Creek at RM 232.6 (Figure 3.3-

[96] Outbreeding depression is progeny that are less adapted to the environment than parents.

1, NRC 2004, as cited in NMFS 2007a, Hamilton et al. 2005). It is not anticipated that under the Proposed Project coho salmon would begin to occupy habitat within the Upper Klamath River and connected waterbodies, and therefore this reach is not analyzed for effects on coho salmon.

Upper Klamath River – Hydroelectric Reach

The Proposed Project would restore access for the Upper Klamath River Population coho salmon to the Hydroelectric Reach, expanding their distribution to include historical habitat along the mainstem Klamath River and all tributaries upstream at least as far as Spencer Creek; including in Jenny, Shovel, and Fall creeks (Hamilton et al. 2005), comprising around 80 miles of potential habitat within the Hydroelectric Reach (DOI 2007, Cunanan 2009). Coho salmon downstream from Iron Gate Dam belonging to the Upper Klamath River Population Unit would migrate upstream of the dam if access was provided (NMFS 2006a). Over time, access to habitat upstream of Iron Gate Dam would benefit the Upper Klamath River Population Unit by: a) extending the range and distribution of the species thereby increasing the coho salmon's reproductive potential; b) increasing genetic diversity in the coho stocks; and c) reducing the species' vulnerability to the impacts of degradation. These benefits would cumulatively result in an increase in the abundance of the coho salmon population (NMFS 2006a). The National Research Council (NRC) of the National Academy of Sciences reviewed causes of decline and strategies for recovery of endangered and threatened fishes of the Klamath Basin. The NRC concluded that "removal of Iron Gate Dam...could open new habitat, especially by making available tributaries that are now completely blocked to coho" (NRC 2004). Coho salmon recolonization of newly accessible habitat was observed following fish ladder installation at Landsburg Dam on the Cedar River, Washington (Kiffney et al. 2009), and following removal of Condit Dam on the White Salmon River, Washington (Allen et al. 2016). The Landsburg Dam was laddered in 2003, and coho salmon were observed within areas upstream of the dam within the first year. By 2011 salmon (with coho salmon being most abundant) occurred within nearly all of the accessible habitat upstream of the dam. Pess (et al. 2011) predicted that within the habitat upstream of Landsburg Dam juvenile coho salmon would establish a population that outnumbered resident salmonid species (e.g., rainbow trout, cutthroat trout) by 40 percent within five years of colonization, suggesting a strong ability of coho salmon to successfully occupy newly accessible habitat.

By eliminating peaking flows in the Hydroelectric Reach and removing the Lower Klamath Project reservoirs, the Proposed Project would support a flow regime that more closely mimics natural conditions in the Lower Klamath River. The reservoir drawdowns would also allow tributaries and springs such as Fall, Shovel, and Spencer creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). As described in Section 3.3.5.5 *Fish Disease and Parasites*, risk of fish disease and parasites for coho salmon would decrease.

Adults would be able to access the Hydroelectric Reach beginning in fall of dam removal year 2. By this time, elevated SSCs from dam removal would likely have dissipated, returning to background levels similar to those of existing conditions. Most sediment released from the reservoirs would likely be eroded within the first six months after dam removal (by June of dam removal year 2), returning sections of river currently inundated by the Lower Klamath Project reservoirs and riverine sections between reservoirs to pool-riffle morphology. Within this reach, coho salmon would generally spawn in tributaries and not within the mainstem Klamath River, but might rear in and migrate through the Hydroelectric Reach. Dam removal would result in the provision of suitable rearing habitat for juveniles and spawning habitat for the few individual coho that might spawn in the mainstem Klamath River. Access to the cooler waters associated with spring inputs in the Hydroelectric Reach would benefit coho salmon rearing in the mainstem (Hamilton et al. 2011). Removal of the Lower Klamath Project reservoirs would result in more favorable water temperature for coho salmon adult migrants, juveniles, and smolts. As described in detail in Section 3.3.5.5 *Fish Disease and Parasites*, it is unlikely that the disease conditions that currently exist downstream of Iron Gate Dam would develop upstream of Iron Gate Dam under the Proposed Project. Access to this reach and the habitat conditions within it would benefit the Upper Klamath River coho salmon population.

Middle and Lower Klamath River

The Proposed Project would release dam-stored sediment downstream to the Lower Klamath River Reach in the short term and would establish a flow and sediment regime that more closely mimics natural conditions in the long term. Suspended sediment effects on coho salmon under the Proposed Project are described in detail in Appendix E.3.2.3, and summarized here.

There are nine coho salmon population units in the Klamath Basin (see the coho salmon subsection of Section 3.3.2.1 *Aquatic Species*). Only negligible effects from suspended sediment would be expected on the three population units in the Trinity River, and on the Lower Klamath River Population Unit. Effects on the Salmon River Population Unit are anticipated to remain similar to existing condition (SEV ranging from 5.4 to 8.4 with sublethal physiological stress) even under a worst impacts on fish scenario (Appendix E.3.2.3, Table E-10), due to dilution of suspended sediment from tributaries in the Middle Klamath River. Effects on the Upper Klamath River, Mid-Klamath River, Shasta River, and Scott River population units under all scenarios are anticipated to be sublethal on most life-stages (Appendix E.3.2.3). Under all scenarios, the small proportion of coho salmon from the Upper Klamath River Population Unit that spawn in the mainstem, as well as their progeny, would suffer 60 to 80 percent mortality due to the effects of suspended sediment on these life stages. This compares to existing conditions high rate of mortality for this small proportion of mainstem spawners predicted to be from 20 to 60 percent depending on severity of conditions (Appendix E.3.1.3). It is believed by experts in the watershed that progeny of mainstem spawning coho salmon experience reduced survival compared to fish produced from tributary spawners (Simondet 2006), since rearing and growth conditions within tributaries are more favorable than in the mainstem. Based on spawning surveys conducted from 2001 through 2017 (Magneson and Gough 2006, Hentz and Wickman 2016, Dennis et al. 2017), from 0 to 13 redds could be affected in dam removal year 1 during the Proposed Project. Many of these redds are thought to be from returning hatchery fish (NMFS 2010a), and thus may be only selecting this habitat after failing to locate the hatchery collection site. Based on the range of escapement estimates of Ackerman et al. (2006), 13 redds (the highest number observed) would be much less than one percent of the natural and hatchery returns to the Klamath River Basin. The Upper Klamath River Population Unit would be expected to recover from these losses in the long term, given the benefits to the population.

Coho salmon smolts from the dam removal year 1 cohort are expected to outmigrate to the ocean beginning in late February, although most natural origin smolts outmigrate to the mainstem Klamath River during April and May (Wallace 2004). Coho smolt releases from Iron Gate Hatchery typically occur in the first three weeks of April (CDFW 2014). Numerous field and laboratory studies have shown that juvenile salmonids actively avoid exposure to high (> 150 mg/L) SSCs, including altering migratory patterns to seek lower turbidity (Bisson and Bilby 1982, Berg and Northcote 1985, Redding et al. 1987, Servizi and Martens 1992, Bash et al. 2001, Carlson et al. 2001, Kemp et al. 2011, Kjelland et al. 2015). Therefore, it is assumed that coho salmon outmigration during the spring of dam removal year 2 would occur within the period of typical outmigration with the lowest predicted SSC. Once in the mainstem Klamath River, coho salmon smolts move downstream fairly quickly (Stutzer et al. 2006). Under the Proposed Project, SSCs would be slightly higher during spring than under existing conditions, and coho salmon smolts are likely to suffer moderate to major stress and reduced feeding depending on scenario (Appendix E.3.2.3, Table E-10).

Under existing conditions, coho salmon smolts outmigrating from the Upper Klamath River, Scott River, and Shasta River populations currently have high mortality rates (35 to 70 percent) presumably as a result of poor water quality and disease (Beeman et al. 2007, 2008), which, in conjunction with physiological stress and reduced growth resulting from the Proposed Project, could result in higher mortality than under existing conditions in the spring of dam removal year 2.

Based on the results of coho salmon outmigrant trapping by the USFWS (2001) on the mainstem Klamath River compared with trapping in the Trinity River from 1997 to 2000 (USFWS 2011), most (greater than 80 percent) coho smolts originate from the Trinity River and Lower Klamath River populations. For the majority of coho salmon smolts, produced from tributaries downstream from Orleans, effects of the Proposed Project would be similar to existing conditions by late April.

The Proposed Project would also result in the release of coarse sediment, as described in Section 3.11 *Geology, Soils, and Mineral Resources* and Appendix F of this EIR. Impacts associated with the release of coarse sediment are expected to affect the same individuals described for suspended sediment above. For example, coarse sediment is predicted to bury redds constructed in fall of dam removal year 1, which are the same redds expected to suffer from suspended sediment (potentially from 0 to 13 redds). In addition, sediment deposition could aggrade pools or overwhelm other habitat features that coho salmon use for adult holding or juvenile rearing. However, the sediment impact on habitat is anticipated to be short term, and pools would likely return to their pre-sediment release depth within one year (USBR 2012).

Additionally, as described in Potential Impact 3.2-1 and Potential Impact 3.2-2, water quality improvements are anticipated to reduce stress to smolts, improving fitness and survival. As discussed in detail in Section 3.2.5.1 *Water Temperature*, dam removal would cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for coho salmon and other salmonids in the mainstem. Cooler water temperatures during fall would benefit upstream migrant adults during fall upstream migration and juvenile redistribution to overwintering habitats by providing a broader window of suitable habitat, starting in dam-removal year 2. A predicted earlier outmigration in response to elevated water temperatures in the spring is also supported by of the scientific literature relating to increased growth rates and thermal response of outmigrating salmonids, as summarized by Hoar (1988). Spring outmigrants could therefore begin an earlier outmigration starting in post-dam-removal year 1, potentially reducing their susceptibility to disease. Coincident with increased with SSCs, in the short term, migrating adults and juveniles rearing or migrating in the mainstem would be exposed to reductions in dissolved oxygen due to the Proposed Project. The risk of sublethal physiological stress and avoidance behavior predicted for migrating adults and juveniles rearing or migrating in the mainstem after dam removal resulting from increased suspended sediment is anticipated to be further exacerbated by reductions in dissolved oxygen.

As described in Section 3.3.5.5 *Fish Disease and Parasites*, the Proposed Project is expected to disrupt many of the existing congruence of factors that lead to high disease parasite concentrations at locations with multiple water quality stressors for fish and resulting high levels of fish disease.

Klamath River Estuary and Pacific Ocean Nearshore Environment

Under the Proposed Project, habitat in the Klamath River Estuary could be affected by elevated sediment during dam removal for about three months (January through March) when a low abundance of coho salmon smolts could be within the estuary during their outmigration to the ocean. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see Section 3.3.5.1 *Suspended Sediment*). However, the increased SSCs predicted to occur in the estuary would not be of sufficient magnitude or duration to result in substantial sublethal or lethal effects on coho salmon individuals (Appendix E.3.2.3). While the magnitude of SSCs released to the Pacific Ocean nearshore environment would be within the range of natural conditions, the duration of elevated SSCs (i.e., weeks) would be greater than would occur under natural (i.e., storm) conditions (i.e., days). Therefore, there also would be elevated SSCs in the Pacific Ocean nearshore environment relative to existing conditions (see Section 3.2.5.2 *Suspended Sediments*). However, no coho salmon adults or juveniles are anticipated to occur within the nearshore environment during this period.

Summary

In the short term, reservoir drawdown associated with dam removal under the Proposed Project could alter SSCs and bedload sediment transport and deposition, causing both lethal and sub-lethal impacts to coho salmon at all life stages. In general, the wide distribution and use of tributaries by both juvenile and adult coho salmon would likely protect the population from the worst short-term impacts of the Proposed Project. A small amount of direct mortality is anticipated for redds from the Upper Klamath Population Unit, and no mortality is anticipated for the other population units under all scenarios. Based on no predicted substantial short-term decrease in coho salmon abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to coho salmon under the Proposed Project in the short term.

Although this EIR finds no significant impact on coho salmon In the short term, the KRRC proposes aquatic resource measures AR-1 (Mainstem Spawning), AR-2 (Juvenile Outmigration), and AR-4 (Iron Gate Hatchery Management) which would further reduce the potential for short-term effects of SSCs on coho salmon eggs, juveniles, and smolts (natural and hatchery production). In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Proposed Project on coho salmon by increasing certainty regarding the effectiveness of the KRRC's proposed aquatic resource measures. Aquatic resource measures are summarized in Section 2.7.8.1 *Aquatic Resource Measures* and detailed in Appendix B: *Definite Plan − Appendix I*. Proposed Aquatic Resource Measure AR-1 includes the development and implementation of a monitoring and adaptive management plan to offset the impacts of Lower Klamath Project dam removal on mainstem spawning. Proposed Aquatic Resource Measure AR-1 actions include a 2-year tributary confluence monitoring effort and addressing sediment and debris obstructions that block volitional upstream passage from the Klamath River into tributaries. Monitoring would occur regularly for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No. 11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-1 Mainstem Spawning (detailed in Potential Impact 3.3-1 above) further specifies that monitoring shall also be conducted following a significant flow event, even if that flow event occurs more than two years following dam removal. Proposed Aquatic Resource Measure AR-1 also includes a spawning habitat evaluation on the Klamath River and tributaries in the Hydroelectric Reach. Most coho salmon spawning occurs in tributaries, and very few coho salmon have been observed spawning in the mainstem Klamath River. Therefore, the spawning habitat actions of Proposed Aquatic Resource Measure AR-1 are focused on offsetting impacts of the Proposed Project on Chinook salmon and steelhead. However, due to the similar spawning habitat requirements of coho salmon to both species, these actions would benefit them as well. If mainstem spawning habitat conditions following dam removal do not meet target metrics[97] developed to offset the anticipated loss of Chinook salmon and steelhead redds due to the Proposed Project, spawning gravel augmentation would be completed within the mainstem, with additional spawning habitat actions within tributaries. Tributary spawning habitat restoration actions to be completed in Jenny Creek, Shovel Creek, Fall Creek, and/or Spencer Creek could include removal of artificial fish passage barriers, or placement of large woody debris to trap and retain spawning gravels. Mitigation Measure AQR-1 Mainstem Spawning (detailed in Potential Impact 3.3-1 above) further specifies the range of actions that shall be conducted in tributaries to offset impacts to coho salmon spawners. Implementation of Proposed Aquatic Resource Measure AR-1 and Mitigation Measure AQR-1 would reduce the short-term potential impacts of SSCs on coho salmon spawning in dam removal year 2 by improving access to tributary habitat where impacts from SSC on habitat in the mainstem can be avoided, and by augmenting spawning gravel ensuring that suitable spawning habitat in mainstem and tributaries is available following dam removal.

Proposed Aquatic Resource Measure AR-2 includes three primary actions: (1) salvaging mainstem overwintering juvenile salmonids prior to reservoir drawdown; (2) maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and

[97] Spawning gravel in the amount of 44,100 yd^2 for fall Chinook salmon and 4,700 yd^2 for steelhead

the Klamath River; and (3) developing a water quality monitoring network, trigger thresholds, and plan for salvaging and relocating juvenile fish from tributary confluence areas to cold water tributaries or nearby off-channel ponds. Implementation of AR-2 would reduce the short-term effects of SSCs to coho salmon juveniles rearing in the mainstem during dam removal by actively transporting up to 500 coho salmon juveniles from vulnerable mainstem areas to off-channel ponds protected from the effects of the Proposed Project, thus offsetting water quality impacts to these coho salmon individuals. Proposed Aquatic Resource Measure AR-2 would also reduce the potential short-term effects of SSCs to migrating coho salmon smolts by maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River. Monitoring would occur regularly for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No. 11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-2 Juvenile Outmigration (detailed in Potential Impact 3.3-1 above) further specifies that monitoring shall also be conducted following a significant flow event, even if that flow event occurs more than two years following dam removal. In addition, proposed Aquatic Resource Measure AR-2 would reduce the potential short-term effects of SSCs to migrating coho salmon smolts by rescuing and transporting smolts if mainstem SSC are high, and water temperatures within tributaries are too poor to provide safe refuge (a decision to be made in regular consultation with the ATWG). These actions would effectively reduce the number of coho salmon juveniles and smolts potentially exposed to periods of high SSC in the mainstem habitat following dam removal, and therefore reduce the proportion of the population experiencing sub-lethal effects or mortality.

The Proposed Project would shift all production of Iron Gate Hatchery coho salmon (75,000 yearling goal) to Fall Creek Hatchery. In the short term, transfer of coho salmon production from Iron Gate Hatchery to Fall Creek Hatchery would have no impact on adult returns. In addition, proposed Aquatic Resource Measure AR-4 proposes that hatchery-reared yearling coho salmon to be released in the spring of dam removal year 2 be held at Iron Gate Hatchery or Fall Creek Hatchery until water quality conditions in the mainstem Klamath River improve to sublethal levels. This would reduce the short-term effects of SSCs to coho salmon smolt released from the hatchery by decreasing the probability that they would be exposed to peak SSC levels, and would increase survival during downstream migration in dam removal year 2.

In the long term, removal of the Lower Klamath Project dams under the Proposed Project would increase habitat availability, restore a more natural flow regime by eliminating peaking flows in the Hydroelectric Reach and removing the Lower Klamath Project reservoirs, restoring more natural seasonal water temperature variation, improve water quality, and reduce the likelihood of fish disease, all of which would be beneficial for coho salmon populations. Substantial declines in abundance resulting from effects of the Proposed Project are not anticipated for more than one year class (i.e., one generation). Dam removal would restore connectivity to habitat on the mainstem Klamath River up to and including Spencer Creek and would create additional habitat within the Hydroelectric Reach. Dam removal would also cause water temperatures to become warmer earlier in the spring and early summer, cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for salmonids in the mainstem.

In the long term, increased adult returns resulting from newly accessible habitat upstream of Iron Gate Dam would offset reductions in adult returns due to cessation of hatchery operations eight years following dam removal. It is anticipated that as a result of the Proposed Project, the coho salmon population would experience an increase in abundance, productivity, population spatial structure, and genetic diversity. In general, free flowing river conditions under the Proposed Project would likely increase adult migration efficiency, decrease outmigrant delay, and increase adult escapement (Buchanan et al. 2011b). The Proposed Project would provide multiple benefits to coho salmon from all Klamath River population units in the long term.

Significance

No significant impact for coho salmon populations in the short term

Beneficial for coho salmon populations in the long term

Potential Impact 3.3-10 Effects on the steelhead population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

The Coho Salmon and Steelhead Expert Panel was convened and charged with answering specific questions that had been formulated to assist with assessing the effects of the Proposed Project on steelhead (Dunne et al. 2011). The conclusion of the Coho Salmon and Steelhead Expert Panel was that the Proposed Project could increase the spatial distribution and abundance of steelhead. This assessment is based on the observations that steelhead would be able to access a substantial extent of new habitat, steelhead are relatively tolerant to warmer water (compared to coho salmon), steelhead are similar to other species (resident redband/rainbow trout) that are currently thriving in upstream habitats, and that while steelhead are currently at lower abundances than historical values, they currently migrate to habitat directly downstream of Iron Gate Dam (e.g., Bogus Creek), and are not yet rare. It is likely that steelhead recolonization would occur rapidly, as was observed for similar steelhead populations following fish ladder installation at Landsburg Dam on the Cedar River, Washington (Kiffney et al. 2009), and following removal of Condit Dam on the White Salmon River, Washington (Allen et al. 2016). Steelhead recolonization of habitat upstream of Condit Dam was notable, with steelhead spawning observed in upper basin tributaries within five years of dam removal.

Under the Proposed Project, steelhead, coho, and fall-run Chinook salmon yearlings and smolts would no longer be released from hatcheries in the Klamath River following post-dam removal year 7. Currently there are no releases of steelhead from hatcheries into the Klamath River. Therefore, the closure of hatcheries eight years following dam removal is not anticipated to result in a decline in adult returns for steelhead. Impacts associated with hatcheries operations in relation to water diversions and minimum bypass flows for fish passage is discussed in Potential Impact 3.3-23 (Iron Gate Hatchery) and Potential Impact 3.3-24 (Fall Creek Hatchery).

The impacts of the Proposed Project on steelhead populations within specific reaches are described below.

Upper Klamath River and Connected Waterbodies

Under the Proposed Project, dam removal would allow steelhead to regain access to the Upper Klamath River upstream of J.C. Boyle Reservoir. Under the Proposed Project, the population's distribution would likely expand to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005). As discussed under Section 3.3.5.3 *Water Quality*, in some years poor water quality in the Keno Impoundment/Lake Ewuana reach may prevent the latest migrants of the summer steelhead run and the earlier migrants from the fall run from accessing upstream spawning habitat in these upper reaches. If no upstream trap and haul is provided at Keno, these fish would be likely to spawn in habitat downstream of Keno Dam in the Hydroelectric Reach (described below), or, in the case of fall-run steelhead, hold below the dam until conditions become passable. However, the majority of the summer steelhead adult migration, much of the fall-run adult steelhead migration, and all of the winter adult steelhead migration is anticipated to occur outside the mid-June to mid-November timeframe in which water quality in the Keno Impoundment/Lake Ewuana reach is typically so poor as to present a migration barrier to adult salmonids. Similarly, juvenile outmigration and run-backs also occur outside this timeframe. Under the Proposed Project, there would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising around 360 miles of additional potentially productive habitat (Huntington 2006, DOI 2007, NMFS 2007b).

Upper Klamath River - Hydroelectric Reach

In the long term, the Proposed Project would restore steelhead access to habitat upstream of Iron Gate Dam and below J.C. Boyle, including an estimated 80 miles of habitat within the Hydroelectric Reach (DOI 2007, Cunanan 2009). Reaches currently inundated by reservoirs and reaches between reservoirs would likely return to a pool-riffle morphology, which would benefit steelhead.

In the short term, adults could first access this reach in winter (summer steelhead) or fall (winter steelhead) of dam removal year 2. Steelhead could use this reach as a migration corridor, as most sediment released from the reservoirs would likely be eroded within the first six months after reservoir drawdown (by June of dam removal year 2) and would not impede upstream movement. By late spring of removal year 2, elevated SSCs resulting from dam removal would likely have returned to low levels unlikely to impact steelhead.

By eliminating peaking flows in the Hydroelectric Reach and removing the Lower Klamath Project reservoirs, the Proposed Project would support a flow regime that more closely mimics natural conditions in the Lower Klamath River. The reservoir drawdowns would also allow tributaries and springs such as Fall, Shovel, and Spencer creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011).

Middle and Lower Klamath River

The Proposed Project would release dam-stored sediment downstream to the Lower Klamath River in the short term and restore a flow regime that more closely mimics natural conditions in the long term. Short-term suspended sediment effects on steelhead populations under the Proposed Project are described in detail in Appendix E.3.2.4, and summarized here.

Under all scenarios, sublethal effects from suspended sediment are anticipated for adult migrants, all spawning (which occurs primarily in tributaries), and outmigrating smolts

(Appendix E.3.2.4, Table E-11). As detailed in Appendix E.3.2.4, mortality is anticipated for the following steelhead life-stages:

- Half-pounder adult: Mortality ranging from just under 20 percent of those present in the mainstem under a least impacts on fish or most-likely impacts on fish scenario, to just over 20 percent under a worst impacts on fish scenario (data on half pounder adult abundance is lacking). Majority remain in tributaries and would not be affected. Some would enter tributaries if conditions within the mainstem were adverse.
- Juvenile age 0: No mortality under a least impacts on fish or most-likely impacts to fish scenario, up to 20 percent mortality of those present in the mainstem under a worst impacts on fish scenario (up to 843 juveniles or around 3 percent of population basin-wide age 0 production in a worst impacts on fish scenario).
- Juvenile age 1: 0 to 20 percent of those present in the mainstem under a least impacts on fish scenario, or up to 40 percent mortality under the most-likely impacts to fish or worst impacts on fish scenario (up to 6,314 juveniles or around 11 percent of population basin-wide age 1 production).
- Juvenile age 2: 0 to 20 percent of those present in the mainstem under a least impacts on fish scenario, or up to 40 percent mortality under the most-likely impacts to fish or worst impacts on fish scenario (up to 5,303 juveniles or around 10 percent of population basin-wide age 2 production in a worst impacts on fish scenario).

As described in detail in Section 3.11 *Geology, Soils, and Mineral Resources* and Appendix F, dam-released sediment associated with the Proposed Project might aggrade pools or overwhelm other habitat features currently used for adult holding and juvenile rearing upstream of Cottonwood Creek. The effect would be short term (less than one year), as pools would quickly return to their pre-sediment release depth (USBR 2012). Within six months the river would revert to and maintain the pool-riffle morphology that currently exists. In the long term, under the Proposed Project, bedload sediment transport would restore vital aquatic habitat for steelhead.

As discussed in detail above, dam removal would cause water temperatures to warm earlier in the spring and early summer, cool earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods. These changes would result in water temperatures that are more favorable for salmonids occurring in the mainstem. Migrating adults and juveniles rearing or migrating in the mainstem after dam removal would be exposed to low dissolved oxygen due to the Proposed Project, but these effects would be short term and of limited spatial extent, and not likely to be of sufficient magnitude to exacerbate effects substantially beyond those anticipated for increased suspended sediment. Long-term effects of the Proposed Project would benefit steelhead using the Lower Klamath River.

The Iron Gate Hatchery does not currently produce steelhead smolts, and no steelhead releases are included under the Proposed Project. Therefore, discontinuing hatchery operations under the Proposed Project would not have a direct effect on the steelhead population, although it would eliminate the potential for additional hatchery production were sufficient numbers of steelhead to enter the hatchery again. As described in Section 3.3.5.6 *Fish Hatcheries*, and 3.3.5.5 *Fish Disease and Parasites*, incidences of disease are expected to be reduced under the Proposed Project through changes to a number of factors underlying disease prevalence. Reducing polychaete habitat would likely reduce the prevalence of *P. minibicornis* infection, although the benefit to the steelhead would not be as great as for coho and Chinook salmon because they are resistant to *C. shasta*.

Klamath River Estuary and Pacific Nearshore Environment

Under the Proposed Project, habitat in the estuary could be affected by elevated sediment releases during dam removal for about three months (January through March) when a low abundance of steelhead juveniles and smolts could be within the Klamath River Estuary. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see Section 3.3.5.1 *Suspended Sediment*). However, the increased SSCs predicted to occur in the estuary would not be of sufficient magnitude or duration to result in substantial sublethal or lethal effects on steelhead salmon individuals (Appendix E.3.2.3). While the magnitude of SSCs released to the Pacific Ocean nearshore environment would be within the range of natural conditions, the duration of elevated SSCs (i.e., weeks) would be greater than would occur under natural (i.e., storm) conditions (i.e., days). Therefore, there also would be elevated SSCs in the Pacific Ocean nearshore environment relative to existing conditions (see Section 3.2.5.2 *Suspended Sediments*). However, no steelhead adults or juveniles are anticipated to occur within the nearshore environment during this period.

Summary

In the short term, reservoir drawdown associated with dam removal under the Proposed Project could alter SSCs and affect steelhead. In general, the short term impacts of suspended sediment resulting from the Proposed Project on steelhead are likely to be substantial for any juveniles rearing in the mainstem. However, there are several aspects of steelhead life history in the Klamath River Watershed that would ameliorate these impacts, and only a limited proportion of the rearing juveniles would be affected. The broad spatial distribution of steelhead in the Klamath Basin and their flexible life history suggests that some juveniles that would otherwise be in the mainstem would avoid the most serious effects of the Proposed Project by: (1) remaining in tributaries for extended rearing, (2) rearing farther downstream where SSC should be lower due to dilution (e.g., the progeny of the adults that spawn in the Trinity River Basin or tributaries downstream from the Trinity River), and/or (3) moving out of the mainstem into tributaries and off-channel habitats during winter. In addition, the life-history variability (e.g., regularly smolting at age 0+, 1+, or 2+) observed in steelhead means that not all individuals in any given year class would smolt during spring of dam removal year 2 and be exposed to the effects of the Proposed Project. Those that do not smolt would remain in tributaries and be unaffected by sediment release. Based on no predicted substantial short-term decrease in steelhead abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to steelhead under the Proposed Project in the short term.

Although this EIR finds no significant impact on steelhead In the short term, the KRRC proposes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) which would further reduce the potential for short-term effects of SSCs on salmonid juveniles and eggs, including steelhead. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Proposed Project on steelhead by increasing certainty regarding the effectiveness of the KRRC's proposed aquatic resource measures. Aquatic resource measures are summarized in Section 2.7.8.1 *Aquatic Resource Measures* and detailed in Appendix B: *Definite Plan − Appendix I*. Proposed Aquatic Resource Measure AR-1 includes the development and implementation of a monitoring and adaptive management plan to offset the impacts of Lower Klamath Project dam removal on mainstem spawning. Proposed Aquatic Resource Measure AR-1 actions include a 2-year tributary confluence monitoring effort and addressing sediment and debris obstructions that block volitional upstream passage from the Klamath River into tributaries. Monitoring would occur regularly for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No. 11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-1 Mainstem Spawning (detailed in Potential Impact 3.3-1) further specifies that monitoring shall also be conducted following a significant flow event, even if that flow event occurs more than two years following dam removal. Proposed Aquatic Resource Measure AR-1 also includes a spawning habitat evaluation on the Klamath River and tributaries in the Hydroelectric Reach. If spawning habitat conditions following dam removal do not meet target metrics[98] developed to offset the anticipated loss of Chinook salmon and steelhead redds due to the Proposed Project, spawning gravel augmentation would be completed within the mainstem, with additional spawning habitat actions within tributaries. Tributary spawning habitat restoration actions to be completed in Jenny Creek, Shovel Creek, Fall Creek, and/or Spencer Creek could include removal of artificial fish passage barriers, or placement of large woody debris to trap and retain spawning gravels. Mitigation Measure AQR-1 Mainstem Spawning (detailed in Potential Impact 3.3-1) further specifies the range of actions that shall be conducted in tributaries to offset impacts to steelhead spawning. Implementation of proposed Aquatic Resource Measure AR-1 and Mitigation Measure AQR-1 would reduce the short-term potential impacts of SSCs on steelhead spawning habitat in dam removal year 2 by improving access to tributary habitat where impacts from SSC on habitat in the mainstem can be avoided, and by augmenting spawning gravel, ensuring that suitable spawning habitat in mainstem and tributaries is available following dam removal. Therefore, it is anticipated that steelhead spawning would not be substantially reduced as a result of the Proposed Project.

Proposed Aquatic Resource Measure AR-2 includes three primary actions: (1) salvaging mainstem overwintering juvenile salmonids prior to reservoir drawdown; (2) maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River; and (3) developing a water quality monitoring network, trigger thresholds, and plan for salvaging and relocating juvenile fish from tributary confluence areas to cold water tributaries or nearby off-channel ponds. Implementation of Proposed Aquatic Resource Measure AR-2 would reduce the short-term effects of SSCs on juvenile steelhead rearing in the mainstem during dam removal by actively transporting juveniles from vulnerable mainstem areas to off-channel ponds protected from the effects of the Proposed Project. Seining efforts would be focused on coho salmon juveniles, but other native fish captured during the seining and trapping effort, including

[98] Spawning gravel in the amount of 44,100 yd^2 for fall Chinook salmon and 4,700 yd^2 for steelhead

juvenile steelhead, would be relocated into tributary streams adjacent to the salvage locations. Proposed Aquatic Resource Measure AR-2 would also reduce the potential short-term effects of SSCs to steelhead smolts by maintaining tributary-mainstem connectivity to ensure volitional fish passage between tributaries and the Klamath River. Monitoring would occur regularly for the two years following dam removal. Additionally, any 5-year flow event of 10,895 cfs or greater on the Klamath River recorded at the USGS Klamath River Below Iron Gate Dam CA gage (No. 11516530) within the first two years following reservoir drawdown would trigger a monitoring effort. Mitigation Measure AQR-2 Juvenile Outmigration (detailed in Potential Impact 3.3-1) further specifies that monitoring shall also be conducted following a significant flow event, even if that flow event occurs more than two years following dam removal. In addition, Proposed Aquatic Resource Measure AR-2 would reduce the potential short-term effects of SSCs to steelhead smolts by rescuing and transporting smolts if mainstem SSCs are high, and water temperatures within tributaries are too poor to provide safe refuge (a decision to be made in regular consultation with the ATWG). These actions would effectively reduce the number of steelhead juveniles and smolts potentially exposed to periods of high SSC in the mainstem following dam removal, and therefore reduce the proportion of the population experiencing impacts.

In the long term, removal of the Lower Klamath Project dams under the Proposed Project would increase habitat availability, restore a more natural flow regime by eliminating peaking flows in the Hydroelectric Reach and removing the Lower Klamath Project reservoirs, restoring more natural seasonal water temperature variation, improve water quality, and reduce the likelihood of fish disease, all of which would be beneficial for steelhead in the long term. Dam removal would restore connectivity to hundreds of miles of historical habitat in the Upper Klamath Basin and would create additional habitat within the Hydroelectric Reach. FERC (2007) concluded that implementing fish passage would help to reduce adverse effects to steelhead associated with lost access to upstream spawning habitats. Hamilton et al. (2011) also concluded that access to additional habitat in the Upper Klamath Basin would benefit steelhead runs. In general, dam removal would likely result in the restoration of more reproducing populations, increased abundance, higher genetic diversity, the opportunity for variable life histories, and use of new habitats (Hamilton et al. 2011). In general, free flowing conditions would likely increase adult migration rate, decrease outmigrant delay, and increase adult escapement (Buchanan et al. 2011b). As discussed in detail above, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer, cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for salmonids in the mainstem. The multiple benefits of the Proposed Project would be beneficial for steelhead populations in the long term.

Significance

No significant impact for steelhead populations in the short term

Beneficial for steelhead populations in the long term

Potential Impact 3.3-11 Effects on the Pacific lamprey population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

The Lamprey Expert Panel (Panel) was convened and charged with answering specific questions that had been formulated to assist with assessing the effects of the Proposed Project on lamprey (Close et al. 2010). The conclusion was that the Proposed Project could increase Pacific lamprey habitat by up to 14 percent with access to habitat upstream of Iron Gate Dam, and even more potential habitat if Pacific lamprey gain access to habitat upstream of Keno Dam. However, the Panel concluded that larval lamprey habitat within much of the newly accessible habitat is of less quality that current larval habitat downstream of Iron Gate Dam, and therefore there might be roughly a total increase of production of outmigrant lamprey (and hence harvest potential) in the range of 1 to 10 percent relative to existing conditions, lower than the percent increase in habitat access. The Panel expects that adult Pacific lamprey would recolonize newly accessible habitat after dam removal, as was observed for Pacific lamprey following fish ladder installation at Landsburg Dam on the Cedar River, Washington (Kiffney et al. 2009), and for Pacific lamprey following removal of Condit Dam on the White Salmon River, Washington (Allen et al. 2016). Larval rearing capacity downstream from Iron Gate Dam is expected to increase after dam removal because a large amount of fine sediment—a major component of larval rearing habitat—would be released through dam removal. The available burrowing habitat for larvae would subsequently decrease over time, but would likely remain higher than under existing conditions because sediment input and transport processes would be restored (Close et al. 2010). In addition, the return to a temperature regime and flows that more closely mimic natural patterns would likely benefit Pacific lamprey, which evolved under those conditions.

Access to habitat would benefit Pacific lamprey by increasing their viability through: (a) extending the range and distribution of the species; (b) providing additional spawning and rearing habitat; (c) increasing the genetic diversity of the species; and (d) increasing the abundance of the Pacific lamprey population (NMFS 2006a). The FERC EIS (2007) concluded that “Removal of Iron Gate Dam provides the greatest potential to expand the range of Pacific lamprey, a species of cultural importance to the tribes, to potential habitat upstream of Iron Gate Dam.”

In a 2015 USFWS regional implementation plan for measures to conserve Pacific lamprey in northern California and the Klamath River Basin, Goodman and Reid (2015) conclude that while there remains some uncertainty about the historical extent of Pacific lamprey in the Upper Klamath Watershed, the removal of the dams and restoration of natural hydrologic flow regimes to the Klamath River would have the greatest positive influence on Pacific Lamprey in the Upper Klamath River. The influence of the Proposed Project on Pacific lamprey populations within specific reaches on the Klamath River is described below.

Upper Klamath River and Connected Waterbodies

Pacific lamprey occurred historically at least to Spencer Creek (Hamilton et al. 2005), and there are no predictions that under the Proposed Project Pacific lamprey would occur in the Upper Klamath River and connected waterbodies.

Upper Klamath River - Hydroelectric Reach

Under the Proposed Project, it is anticipated that Pacific lamprey would migrate upstream of the location of Iron Gate Dam (NMFS 2006a). The Proposed Project would provide Pacific lamprey with access to the Hydroelectric Reach and to the mainstem Klamath River and its tributaries upstream at least as far as Spencer Creek, including Jenny, Shovel, and Fall creeks (Hamilton et al. 2011). Most sediment released from the reservoirs would likely be eroded within the first six months after dam removal (by June of dam removal year 2), returning sections of river currently inundated by reservoirs, and riverine sections between reservoirs, to a pool-riffle morphology. After erosion of dam-stored sediment, the Hydroelectric Reach would likely contain gravel suitable for lamprey spawning.

By eliminating peaking flows in the Hydroelectric Reach and removing the Lower Klamath Project reservoirs, the Proposed Project would support a flow regime that more closely mimics natural conditions. Drawing-down the reservoirs would also allow tributaries and springs such as Fall, Shovel, and Spencer creeks and Big Springs to flow directly into the mainstem Klamath River. These changes would result in more favorable water temperatures for native fishes, and improved water quality. These changes would provide a long-term benefit to Pacific lamprey populations that would occur within the Hydroelectric Reach.

Middle and Lower Klamath River

The Proposed Project would release dam-stored organic sediment and reduce dissolved oxygen downstream to the Lower Klamath River in the short term, and improve water quality and restore a flow regime that more closely mimics natural conditions in the long term. Suspended sediment effects on Pacific lamprey populations under the Proposed Project are described in detail in Appendix E.3.2.5, and summarized here.

Under the most-likely impacts to fish scenario or worst impacts on fish scenario, sub-lethal effects from suspended sediment are anticipated for outmigrants, and for Pacific lamprey migrating to or from the Trinity River or tributaries farther downstream (Appendix E.3.2.5, Table E-13). High rates of mortality are predicted for ammocoetes (lamprey larvae) in the mainstem Klamath River during winter and spring of dam removal year 2. However, there is little information on the effects of suspended sediment on Pacific lamprey. This analysis used the effects of suspended sediment on salmonids to predict effects on Pacific lamprey, with the assumption that effects on Pacific lamprey are equivalent or less severe than on salmonids. In general, most life stages of Pacific lamprey appear more resilient to poor water quality conditions (such as suspended sediment) than salmonids (Zaroban et al. 1999), so this is likely a conservative assessment (an overestimate) of potential effects. In addition, Goodman and Hetrick (2017) report that in a 2008 ammocoete survey within the Klamath Basin no Pacific Lamprey were detected in the reach from Iron Gate Dam downstream to the confluence with the Shasta River (RM 179.5), and the densities did not approach levels observed elsewhere in the watershed until the confluence with the Scott River (RM 145.1). Therefore, the proportion of the Pacific lamprey population in the Klamath River potentially exposed to the highest SSCs during dam removal is low. In addition, recent genetic analysis of Pacific lamprey (Goodman and Reid 2012) indicates a high degree of historical gene flow even across expansive distances of the northern Pacific Rim as a result of low fidelity of Pacific lamprey progeny to their natal stream. This suggests that impacts to Pacific lamprey in the Klamath River are unlikely to affect the metapopulation.

As described for salmonid species above, the Proposed Project would affect spawning and incubation in the short term in the area between Iron Gate Dam and Cottonwood Creek by burying gravel in dam-released sediment and increasing the proportion of sand in the bed. This could reduce the quality of spawning habitat In the short term, but also may increase suitability of habitat for rearing ammocoete (Close et al. 2010). After a flushing flow of at least 6,000 cfs, the bed is expected to maintain fractions of sand, gravel, and cobble which would be expected under natural conditions (suitable for Pacific lamprey spawning). Based on the historical record a sufficient flushing flow would likely occur within five years following dam removal.

The Proposed Project would establish a flow regime that more closely mimics natural conditions in the Lower Klamath River Reach. Dam removal would cause water temperatures to have natural diurnal variations. These changes would result in water temperatures that are more similar to those that Pacific lamprey evolved with and would improve water quality. These long-term changes would likely provide a benefit to Pacific lamprey in the Lower Klamath River.

Klamath River Estuary and Pacific Ocean Nearshore Environment
Under the Proposed Project, habitat in the estuary could be affected by sediment releases during dam removal for about three months (January through March) when a low abundance of Pacific lamprey ammocoetes could be within the estuary during outmigration. After this time, SSCs would return to levels similar to existing conditions. SSCs in the Klamath River Estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see Section 3.3.5.1 *Suspended Sediment*). However, the increased SSCs predicted to occur in the estuary would not be of sufficient magnitude or duration to result in substantial sublethal or lethal effects on Pacific lamprey individuals (Appendix E.3.2.5). While the magnitude of SSCs released to the Pacific Ocean nearshore environment would be within the range of natural conditions, the duration of elevated SSCs (i.e., weeks) would be greater than would occur under natural (i.e., storm) conditions (i.e., days). Therefore, there also would be elevated SSCs in the Pacific Ocean nearshore environment relative to existing conditions (see Section 3.2.5.2 *Suspended Sediments*). However, few Pacific lamprey adults (and no juveniles) are anticipated to occur within the nearshore environment during this period.

Summary
In the short term, reservoir drawdown associated with dam removal under the Proposed Project would alter SSCs and bedload sediment transport and deposition and could affect Pacific lamprey. The Proposed Project would have short-term effects related to SSCs, bedload sediment transport and deposition, and water quality (particularly dissolved oxygen). As described in detail in Appendix E.3.2.5, Pacific lamprey use the mainstem Klamath River for several aspects of their life history. Because multiple year classes of Pacific lamprey rear in the mainstem Klamath River at any given time, and since adults would migrate upstream over the entire year, including January of dam removal year 2 when effects from the Proposed Project would be most pronounced, effects on Pacific lamprey adults and ammocoetes could be much higher in the mainstem Klamath River than under existing conditions. However, because of their wide spatial distribution and low observed occurrence downstream of Iron Gate Dam, most of the population would likely avoid the most severe suspended sediment pulses resulting from the Proposed Project and a substantial reduction in abundance is not anticipated. In addition, Pacific lamprey are considered to have low fidelity to their natal streams (FERC 2007), and may not enter the mainstem Klamath River if environmental

conditions are unfavorable in dam removal year 2. Migration into the Trinity River and other Lower Klamath River tributaries may also increase during dam removal year 2 because of poor water quality in the mainstem Klamath River. Low fidelity also increases the potential that Pacific lamprey can recolonize mainstem habitat if ammocoetes rearing there suffer high mortality. In addition, the geographic range of the Pacific lamprey population is very large and disperse (Goodman and Reid 2012), and thus the percentage of adult and larval Pacific lamprey that would be affected by the Proposed Project relative to the population as a whole would be minor (although no data are available to estimate percentage of population affected). Based on no predicted substantial short-term decrease in Pacific lamprey abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the Pacific lamprey population under the Proposed Project in the short term.

Although this EIR finds no significant impact on Pacific lamprey In the short term, the KRRC proposes aquatic resource measures AR-1 (Mainstem Spawning) which would further reduce the potential for short-term effects of SSCs on Pacific lamprey spawners. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, Mitigation Measures AQR-1, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Proposed Project on Pacific lamprey by increasing certainty regarding the effectiveness of the KRRC's proposed aquatic resource measure. Aquatic resource measures are summarized in Section 2.7.8.1 and detailed in Appendix B: *Definite Plan − Appendix I*. Proposed Aquatic Resource Measure AR-1 includes the development and implementation of a monitoring and adaptive management plan to offset the impacts of Lower Klamath Project dam removal on mainstem spawning. Proposed Aquatic Resource Measure AR-1 actions include a 2-year tributary confluence monitoring effort and addressing sediment and debris obstructions that block volitional upstream passage from the Klamath River into tributaries. Implementation of AR-1 would reduce the short-term impacts of SSCs on Pacific lamprey spawning in dam removal years 1 and 2 by improving access to tributary habitat where impacts from SSC in the mainstem can be avoided. Therefore, it is anticipated that fewer Pacific lamprey would spawn in the mainstem prior to and following the Proposed Project, further decreasing the proportion of the population exposed to high SSC.

In the long term, the Proposed Project would provide access to habitat upstream of Iron Gate Dam at least as far as Spencer Creek. It is anticipated that as a result of the Proposed Project the Pacific lamprey population within the Klamath Basin would have an increase in abundance and productivity due to increases in habitat availability, and improved flow regime, water quality, and temperature variation. Based on no predicted substantial long-term decrease in Pacific lamprey abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the Pacific lamprey population under the Proposed Project in the long term. Furthermore, implementation of the Proposed Project would be beneficial for Pacific lamprey in the long term.

Significance

No significant impact for Pacific lamprey populations in the short term

Beneficial for Pacific lamprey populations in the long term

Potential Impact 3.3-12 Effects on the green sturgeon population due to short-term sediment releases and long-term changes in habitat quality due to dam removal.
Southern DPS Green Sturgeon may enter the Klamath River Estuary to forage during the summer months. They would not be present when the most severe effects of dam removal are occurring and are not expected to be affected by the Proposed Project. The remainder of this section focuses on the effects of the Proposed Project on the Northern Green Sturgeon DPS. Northern Green Sturgeon are an anadromous species that enter the Klamath River to spawn from March through July (Table 3.3-9). Green sturgeon spawn primarily in the lower 67 miles of the mainstem Klamath River (downstream from Ishi Pishi Falls), in the Trinity River, and occasionally in the lower Salmon River. Since green sturgeon do not occur upstream of Ishi Pishi Falls, they would only be affected by Proposed Project effects that would extend downstream of these falls.

Middle and Lower Klamath River
The Proposed Project would release dam-stored sediment downstream to the Lower Klamath River in the short term. There is not extensive literature on the effects of suspended sediment on green sturgeon. This analysis is based on available information of the effects of SSC on salmonids, with the assumption that effects of suspended sediment on sturgeon are likely less than or equal to those on salmonids. Suspended sediment effects on Northern Green Sturgeon populations under the Proposed Project are described in detail in Appendix E.3.2.6 and summarized here.

As described in Appendix E.3.2.6, green sturgeon in the Klamath River spawn approximately every four years. The result of this life history pattern is that up to 75 percent of the mature adult green sturgeon population (as well as 100 percent of sub-adults) can be assumed to be in the ocean during dam removal year 2 and avoid effects associated with the Proposed Project. For the 25 percent of the adult population that could be in the Klamath River during dam removal year 2, only slightly higher impacts are predicted for adults than under existing conditions under all scenarios (Appendix E.3.2.6, Table E-14), mostly because Northern Green Sturgeon distribution within the mainstem Klamath River is primarily limited to areas downstream from Orleans, where the effects of SSC resulting from the Proposed Project are more diluted from tributary accretion. Green sturgeon females are broadcast spawners that lay thousands of adhesive eggs that settle into the spaces between cobble substrates. Eggs in the mainstream Klamath River are vulnerable to suspended sediment under existing conditions as a result of the contributions of multiple tributaries in the Middle Klamath River (Appendix E 3.1.6). From 40 to 60 percent mortality is predicted for incubating eggs and larval life stages under all scenarios.

Juvenile green sturgeon typically rear for one year in the Klamath River system (M. Belchik, pers. comm., 2008), but may rear for up to three years before they migrate to the estuary and the ocean, usually during summer and fall. Moderate physiological stress is predicted for rearing juveniles under a least impacts on fish scenario. Under a most-likely impacts to fish or worst impacts on fish scenario major physiological stress is predicted (Appendix E.3.2.6). Around 30 percent of green sturgeon juveniles rear in the Trinity River and would not be exposed to SSC from the Proposed Project.

Bedload sediment effects related to dam-released sediment would not extend as far downstream to Ishi Pishi Falls (USBR 2012) and would not affect Northern Green Sturgeon.

The Proposed Project would improve water quality, and reduce instances of algal toxins. These long-term effects would benefit Northern Green Sturgeon in the Lower Klamath River.

Klamath River Estuary and Pacific Ocean Nearshore Environment

Rearing for more than one year is rarely observed in the mid-Klamath River (M. Belchik, pers. comm., 2008), but juvenile green sturgeon may rear for additional months or years in the estuary before migrating to the ocean. Under the Proposed Project, habitat in the Klamath River Estuary could be affected by elevated suspended sediment during dam removal for about three months during winter, when juvenile green sturgeon could be rearing in the estuary. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see Section 3.3.5.1 *Suspended Sediment*). However, the increased SSCs predicted to occur in the estuary would not be of sufficient magnitude or duration to result in substantial sublethal or lethal effects on green sturgeon juveniles (Appendix E.3.2.6). While the magnitude of SSCs released to the Pacific Ocean nearshore environment would be within the range of natural conditions, the duration of elevated SSCs (i.e., weeks) would be greater than would occur under natural (i.e., storm) conditions (i.e., days). Therefore, there also would be elevated SSCs in the Pacific Ocean nearshore environment relative to existing conditions (see Section 3.2.5.2 *Suspended Sediments*). However, few green sturgeon adults or juveniles are anticipated to occur within the nearshore environment during this period.

Summary

In the short term, reservoir drawdown associated with dam removal under the Proposed Project would alter water quality and SSCs and could affect Northern Green Sturgeon. Overall the effects of the Proposed Project are most likely to include physiological stress, inhibited growth, and high mortality for incubating eggs. Northern Green Sturgeon in the Klamath Basin have the following traits likely to enhance the species' resilience to impacts of the Proposed Project:

- Most of the Northern Green Sturgeon population (sub-adult and adult) would be in the ocean during the year of the Proposed Project (dam removal year 2) and would be unaffected (Appendix E.3.2.6).
- Approximately 30 percent of the Northern Green Sturgeon population that spawn and rear in the Trinity River and would be unaffected.
- Much of the spawning and rearing of Northern Green Sturgeon occurs downstream from the Trinity River, where sediment concentrations would be similar to existing conditions.

Northern Green Sturgeon are long-lived (greater than 40 years) and are able to spawn multiple times (approximately 8 times in their lifetime) (Klimley et al. 2007), so effects on the spawning effort of a proportion of adults for one year are anticipated to have little influence on the population as a whole. Because there would be no predicted substantial short-term decrease in green sturgeon abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the green sturgeon population under the Proposed Project in the short term.

In the long term, suspended sediment levels would return to levels similar to existing conditions, and removal of dams would result in improvements in water quality, temperature variation, and algal toxins which could affect Northern Green Sturgeon. Because there would be no predicted substantial long-term decrease in green sturgeon abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the green sturgeon population under the Proposed Project in the long term.

Significance

No significant impact for green sturgeon populations in the short term

No significant impact for green sturgeon populations in the long term

Potential Impact 3.3-13 Effects on Lost River and shortnose sucker populations due to short- and long-term changes in habitat quality and quantity due to dam removal.

A Resident Fish Expert Panel (Panel) was convened to compare the potential effects of the Proposed Project and existing conditions on resident fish, including sucker populations (Buchanan et al. 2011a). The Panel noted that the populations of Lost River and shortnose sucker in Upper Klamath lake are currently self-sustaining, whereas the populations in the Hydroelectric Reach (Iron Gate and Copco reservoirs) are not self-sustaining. The Panel concluded that most factors limiting the production of Lost River and shortnose sucker populations occur in Upper Klamath Lake (e.g., poor water quality, nonnative fish predation and competition, lack of emergent vegetation rearing habitat), upstream of the Area of Analysis for aquatic resources.

Upper Klamath River and Connected Waterbodies

The Proposed Project has no elements that would substantially alter habitat conditions for Lost River and shortnose sucker populations in the Upper Klamath River upstream of Keno/Lake Ewuana. Facilitating the movement of anadromous fish presents a relatively low risk of introducing pathogens to sucker species upstream of Iron Gate Dam (NMFS 2006a). Generally, with the exception of *F. columnaris* and Ich, pathogens associated with anadromous fish do not impact non-salmonids (e.g., suckers) (NMFS 2006a). In the most recent review of effects of interactions between reintroduced anadromous fish and federally listed suckers, the USFWS concludes that indirect effects of removal of the Lower Klamath Project dams is "not likely to adversely affect" listed suckers (Roninger 2012).

Upper Klamath River - Hydroelectric Reach

Lost River and shortnose sucker individuals are found within Lower Klamath Project reservoirs in the Hydroelectric Reach (Desjardins and Markle 1999). The Proposed Project would eliminate reservoir habitat, and as dams within the Hydroelectric Reach were removed, sediment would move downstream. However, the Lost River and shortnose suckers in these reservoirs are considered by the USFWS (2013) as "sink populations", as they are not likely self-sustaining because of low recruitment due to the lack of access to spawning habitats, citing Moyle (2002), and NRC (2004). Buettner et al. (2006) conclude that since little or no reproduction occurs downstream from Keno Dam, and there is no potential for interaction with upstream populations, they are not considered to substantially contribute to the achievement of conservation goals or recovery. This is also consistent with the findings of Hamilton et al. (2011), and NRC

(2004). In addition, Miller and Smith (1981) asserted that sucker hybridization was most pronounced in these reservoirs, prompting Buettner et al. (2006) and others to caution against relocating individuals from Iron Gate and Copco reservoirs into the Upper Klamath Lake population.

Middle and Lower Klamath River, Estuary, and Pacific Ocean Nearshore Environment
No Lost River or shortnose suckers have been documented to occur downstream of Iron Gate Dam and therefore these reaches are not considered in the potential impact analysis for this EIR.

Summary
In the short term, reservoir removal associated with dam removal under the Proposed Project could alter habitat availability and affect Lost River and shortnose suckers in Iron Gate and Copco reservoirs. All individual suckers occurring within these reservoirs would likely be lost within dam removal year 2; however, these individuals are not considered to substantially contribute to the achievement of conservation goals or recovery, since little or no reproduction occurs downstream from Keno Dam (Buettner et al. 2006), and there is no potential for interaction with upstream populations (Hamilton et al. 2011). Although both species are fully protected species under California Fish and Game Code, Assembly Bill Number 2640 (Wood 2018) added Section 2081.11 to the Fish and Game Code to allow the take of both sucker species resulting from impacts attributable to the decommissioning and removal of the Lower Klamath Project facilities, consistent with CDFW take provisions. Based on the best available estimates of Lost River and shortnose sucker abundance in the Lower Klamath Project reservoirs, there are likely fewer than 1,000 adult suckers of both species in all reservoirs combined (USFWS 2012, Desjardins and Markle 1999), with a combined suitable sucker area of less than 2,500 acres. The populations in Upper Klamath Lake are estimated at 50,000 to 100,000 Lost River sucker (USFWS 2013b), and up to 25,000 shortnose suckers (USFWS 2013c), within around 79,000 acres of suitable habitat in Upper Klamath Lake and connected water bodies. Therefore, a loss of the suckers in Lower Klamath Project reservoirs represents around less than 1.5 percent of the total sucker population, and a loss of less than 3.5 percent of the total suitable sucker habitat. Based on no predicted substantial (< 1.5 percent) short-term decrease in Lost River and shortnose suckers' abundance of a year class, or substantial decrease in habitat quality or quantity (<1.5 percent), the Proposed Project would not cause a significant impact to the Lost River and shortnose sucker populations in the short term.

In the long term, reservoir removal associated with dam removal under the Proposed Project would eliminate habitat availability and affect Lost River and shortnose suckers in Lower Klamath Project reservoirs. All individual suckers occurring within these reservoirs would likely be lost within the short term and would not be replaced in the long term. However, as described above, these individuals are not considered to substantially contribute to the achievement of conservation goals or recovery of the populations (Hamilton et al. 2011). In addition, and as described above, the loss of the sucker population and suitable habitat in the Lower Klamath Project reservoirs is a minor proportion of the total sucker population and suitable habitat area. Based on no predicted substantial long-term decrease in Lost River and shortnose suckers' abundance of a year class, or substantial decrease in habitat quality or quantity, the Proposed Project would not cause a significant impact to the Lost River and shortnose sucker populations in the long term.

Although this EIR finds no significant impact on Lost River and shortnose suckers in the short-or long-term, the Proposed Project includes aquatic resource measure AR-6 (Suckers) to reduce the short- and long-term effects of reservoir removal. Aquatic resource measures are summarized in Section 2.7.8.1 *Aquatic Resource Measures* and detailed in Appendix B: *Definite Plan − Appendix I*. AR-6 includes two primary actions including reservoir and river sampling to estimate the abundance of suckers in the Hydroelectric Reach and conduct genetic testing for hybridization, and sucker salvage and release into waterbodies isolated from the Upper Klamath Lake Populations. As discussed above, Section 2081.11 was added to the Fish and Game Code to authorize take of Lost River and shortnose suckers, subject to certain conditions. CDFW (2018b) has reviewed AR-6 and preliminarily agreed that the Proposed Project with implementation of AR-6 potentially meets the standards for take authorization under Fish and Game Code, section 2081.11. The proposed actions are anticipated to increase the survival of individual Lost River and shortnose suckers currently inhabiting the Hydroelectric Reach, without increasing exposure of the Upper Klamath Lake population to adults with a high degree of hybridization. The number of translocated fish would not exceed 3,000 fish, which is the capacity of the currently-identified recipient waterbody (Tule Lake). Tule Lake currently supports both sucker species and has suitable habitat for translocation site. In addition, Tule Lake is isolated from the sucker population in Upper Klamath Lake, and thus this measure would not risk influencing the sucker populations designated as recovery populations in Upper Klamath Lake.

Significance

No significant impact for Lost River and shortnose sucker populations in the short term

No significant impact for Lost River and shortnose sucker populations in the long term

Potential Impact 3.3-14 Effects on the redband trout population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

A Resident Fish Expert Panel (Panel) was convened to compare the potential effects of the Proposed Project and existing conditions on resident fish, including redband trout (Buchanan et al. 2011a). The Panel predicted that following the Proposed Project, the abundance of redband trout in the free-flowing reach between Keno Dam and Iron Gate Dam could increase significantly. In addition, the Panel expects the existing trout and colonizing anadromous steelhead to co-exist (or even for the redband to produce anadromous progeny), as they do in other watersheds, although there may be shifts in abundance related to competition for space and food. The effects of implementing the Proposed Project on redband trout populations within specific reaches of the Klamath River are described below.

Upper Klamath River and Connected Waterbodies

Under the Proposed Project, redband trout would be able to migrate more successfully from the Hydroelectric Reach to the Upper Klamath Basin (Hamilton et al. 2011) than under existing conditions. Redband trout could be affected by increased predation from reintroduced anadromous salmonids, but this loss might be offset by an increase in available food sources (e.g., eggs, fry, and juveniles of reintroduced salmonids) (Hamilton et al. 2011). Furthermore, anadromous steelhead trout and resident rainbow/redband trout co-existed and intermingled prior to the construction of Copco No. 1 Dam in 1917. There are many examples from nearby river systems in the Pacific Northwest showing that wild anadromous salmon and resident rainbow/redband trout can co-exist and maintain abundant populations without negative consequences. The Deschutes River in Oregon, the Yakima River in Washington, and the river systems in Idaho are examples (NMFS 2006a).

Facilitating the movement of anadromous fish presents a relatively low risk of introducing pathogens to resident fish upstream of Iron Gate Dam (NMFS 2006a).

Upper Klamath River - Hydroelectric Reach

Under existing conditions, redband trout are found within the California portion of the Area of Analysis within the Hydroelectric Reach, including within all riverine areas and reservoirs. Spawning primarily occurs within Shovel and Spencer creeks. Redband trout are currently prevented from migrating between some tributaries and the reservoirs to complete their life cycle because of poorly functioning fishways at J.C. Boyle Dam (DOI 2007, NMFS 2007b). Under the Proposed Project, redband trout would be able to migrate more successfully than under existing conditions (Hamilton et al. 2011). Approximately 4 mi (6.4 km) of habitat has been adversely affected by the dewatered flows in the Bypass Reach, and 17 mi (27.4 km) of habitat has been adversely affected by the daily fluctuating flows in the Peaking Reach (NMFS 2006a). In addition, the NMFS (2006a) finding regarding J.C. Boyle flow operations stated, “Current Project operations, particularly sediment blockage at the J.C. Boyle Dam, the flow regime, and peaking operations, negatively affect the redband trout fishery.”

Under the Proposed Project, the establishment of a flow regime that more closely mimics natural conditions, eliminates hydroelectric peaking and associated negative aquatic impacts, would benefit the redband trout populations in the Hydroelectric Reach. Redband trout throughout this reach of the mainstem would be affected by high SSCs for a period of three to four months during reservoir drawdown associated with the Proposed Project. Redband trout in riverine reaches between the reservoirs in the Hydroelectric Reach would be vulnerable to effects of sediment released during dam removal and bedload deposition (Newcombe and Jensen 1996, Buchanan et al. 2011a). However, SSCs would be the result of sediment stored in J.C. Boyle and Copco reservoirs, which is relatively small potential impact (USBR 2012), and a large proportion of the adult redband trout population should be already spawning in Spencer or Shovel creeks during the dam removal. Juvenile redband trout outmigrating from Spencer Creek would be expected to recolonize the mainstem by late spring or summer when water conditions become suitable. Those in the affected area could move to tributaries for refuge.

The Proposed Project would eliminate reservoir habitat, returning sections of river currently inundated by reservoirs and riverine sections between reservoirs to a pool-riffle morphology. Although most redband trout are anticipated to continue to spawn in tributaries, modeling data indicate that after dam removal, spawning gravel in all sections of the Hydroelectric Reach would be within the range usable for redband trout, but the amount of sand within the bed within former reservoir sections might inhibit spawning success in the short term. Riverine sections between reservoirs would be expected to contain gravel with very little sand, suggesting high-quality spawning habitat would become available within a few years following dam removal. The initial movement of coarse and fine sediment after drawdown would likely create unfavorable conditions for redband trout within the mainstem Klamath River, but these conditions would be short term. Buchanan et al. (2011a) estimate that 43 miles of additional riverine habitat would be available to resident redband trout as a result of the Proposed Project. The adfluvial individuals within this reach would likely adopt a fluvial[99] life history, which is unlikely to affect the sustainability of the population. Overall migratory opportunities would increase for redband trout, increasing resiliency to disturbance over the short and long-term. The Proposed Project would also increase the number of thermal refugia available to redband trout as they would have access to more tributaries, as well as to the cold water areas near the mouths of tributaries and the many springs in this reach.

Middle and Lower Klamath River
No redband trout occur downstream of Iron Gate Dam, and therefore these reaches are not considered in the potential impact analysis for this EIR. However, in the long term redband trout would have access to habitat in the Middle Klamath River, and they are anticipated to use cold-water tributaries and portion of the mainstem river. The resident trout currently within the Middle Klamath River (rainbow trout) are genetically very similar to the redband trout currently present upstream of Iron Gate Dam; these two populations that are currently isolated would revert to a connected and sustainable population (Buchanan et al. 2011a).

Summary
In the short term, the Proposed Project would have impacts related to SSCs and bedload movement. However, very little sediment is stored in J.C. Boyle Reservoir, and only a small proportion of the redband population is expected to be exposed to short-term effects. Based on no predicted substantial short-term decrease in redband trout abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the redband trout population under the Proposed Project in the short term.

In the long term, dam removal would restore connectivity among the Middle Klamath Basin, the Hydroelectric Reach and its tributaries, and the Upper Klamath Basin, and would rehabilitate and increase availability of riverine habitat within the Hydroelectric Reach. Based on a long-term substantial increase in redband trout habitat quality and quantity, the Proposed Project would be beneficial for redband trout in the long term.

Significance
No significant impact for redband trout population in the short term

Beneficial for redband trout population in the long term

Potential Impact 3.3-15 Effects on the eulachon population due to short-term sediment releases and long-term changes in habitat quality due to dam removal.
The Proposed Project would release dam-stored sediment downstream to the Lower Klamath River and Estuary. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial (>500 mg/L) and would be higher than the extreme values estimated by the sediment transport model for existing conditions. Predicted increases in SSCs under the most-likely impacts to fish scenario are within the range of existing extreme conditions (Appendix E.4). Under a worst impacts on fish scenario SSCs could be higher than typically occur within the estuary (>1,000 mg/L) for a period of weeks. Adult eulachon entering the Klamath River in the

[99] Fluvial life history is resident trout spawning in tributaries and maturing within a larger mainstem river.

winter and spring of dam removal year 2 may be exposed to high SSCs for a portion of their migration period. Although no analysis of the effects of SSCs on eulachon is available, based on application of the Newcombe and Jensen (1996) approach using studies of the effects on other estuary species, it is predicted that under a most-likely impacts to fish or worst impacts on fish scenario mortality of eulachon adults would occur under the Proposed Project, unless individuals migrate out of the estuary to avoid poor water quality conditions (as has been observed in the Columbia River watershed, NMFS 2010b). Mortality is also predicted for spawning, incubation, and larval life stages under the Proposed Project. However, eulachon have a relatively long period of the year when they could potentially spawn in the Klamath River (January through April; Larson and Belchik 1998), and a relatively short duration of occurrence within freshwater (around one month), increasing the probability that most of the population would migrate and spawn either before or after the largest pulses of SSCs (predicted to be over 1,000 mg/L for the month of January under a worst impacts on fish scenario, Appendix E.4). Therefore, no substantial reduction in the abundance of a year class is predicted. Based on no predicted substantial short-term decrease in eulachon abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the eulachon population under the Proposed Project in the short term. Within a short duration (< 6 months) SSCs within the Klamath River Estuary are predicted to return to existing levels (Appendix E.4). There is no predicted substantial long-term decrease in eulachon abundance of a year class, or substantial decrease in habitat quality or quantity, and thus there would not be a significant impact to the eulachon population under the Proposed Project in the long term.

Significance

No significant impact for eulachon population in the short term and long term

Potential Impact 3.3-16 Effects on the longfin smelt population due to short-term sediment releases and long-term changes in habitat quality due to dam removal.

The Proposed Project would release dam-stored sediment downstream to the Klamath River Estuary. Longfin smelt entering the Klamath River in the winter and spring of dam removal year 2 may be exposed to high SSCs for a portion of their migration period. Although no analysis of the effects of SSCs on longfin smelt is available, based on application of the Newcombe and Jensen (1996) approach using studies of the effects on other estuary species, it is predicted that under a most-likely impacts to fish or worst impacts on fish scenario mortality would be higher under the Proposed Project than under existing conditions for a period of weeks. However, as described for eulachon above, the protracted migration season for longfin smelt (throughout the year), and relatively short duration of occurrence in the estuary (less than two months), increases the probability that most of the population would migrate and spawn either before or after the largest pulses of SSCs (predicted to be two weeks in duration or less). Based on no predicted substantial short-term decrease in longfin smelt abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the longfin smelt population under the Proposed Project in the short term. Within a short duration (< 6 months) SSC within the Klamath River Estuary are predicted to return to existing levels (Appendix E.4), and thus there is no predicted substantial long-term decrease in longfin smelt abundance of a year class, or substantial decrease in habitat quality or quantity, and there would not be a significant impact to the longfin smelt population under the Proposed Project in the long term.

Significance

No significant impact for longfin smelt population in the short term and long term

Potential Impact 3.3-17 Effects on species interactions between introduced resident fish species and native aquatic species due to short- and long-term changes in habitat quality and quantity due to dam removal.

Introduced fish species threaten the diversity and abundance of native fish species through competition for resources, predation, interbreeding with native populations, and causing potential physical changes to the invaded habitat (Moyle 2002). Introduced resident species occur in Lake Ewuana and Upper Klamath Lake, but the Proposed Project would not affect populations in this area.

As described in detail in Section 3.20.2.3 *Lower Klamath Project Reservoir-based Recreation*, the reservoirs currently provide a recreational fishery for non-native fishes including largemouth bass, trout, catfish, crappie, and sunfish (Hamilton et al. 2011). Fishing is popular in Copco No. 1 and Iron Gate reservoirs, especially for yellow perch (Hamilton et al. 2011). Adults yellow perch are opportunistic predators that feed on small fish, potentially including native fish species. Juvenile and adult largemouth bass tend to feed on larger invertebrates and fish as well, potentially including native species. The Proposed Project would eliminate reservoir habitat upstream of Iron Gate Dam, and thus the abundance of introduced resident species would decline substantially or be eradicated (Buchanan et al. 2011a), providing a benefit to native aquatic species.

A few introduced resident species occur in the Middle and Lower Klamath River, but water velocities within riverine habitat are too high for the introduced species that in general are adapted to the lotic conditions in the reservoirs in which they were introduced. Under the Proposed Project, conditions would be expected to become even less suitable for introduced resident species. This effect would be beneficial for native aquatic species in the short and long term.

Significance

Beneficial for the effects of introduced resident fish species on aquatic species in the short term and long term

Potential Impact 3.3-18 Effects on aquatic species from interactions among fish species due to short- and long-term changes in habitat quantity due to dam removal.

The Proposed Project would restore access for anadromous salmon and steelhead to habitat upstream of Iron Gate Dam, as described in detail above. Restoration of access would result in anadromous salmon and steelhead potentially interacting with resident redband trout and bull trout, with the potential for competition and predation. These species evolved together in the Upper Klamath Basin of the Klamath River, and co-existed prior to the construction of dams (Goodman et al. 2011).

Anadromous salmonids currently co-exist with resident rainbow trout and resident cutthroat trout downstream from Iron Gate Dam, without any obvious detriment to these native species or the aquatic ecosystem in which they reside. While there is little information on the nature of any competitive interactions between steelhead and resident trout in the Klamath Basin, research does suggest that in some circumstances, resident trout may have a competitive edge over steelhead (NMFS 2006a). Conversely, research has shown that hatchery salmon supplementation can negatively impacted resident trout abundance and salmonid biomass in a Washington watershed (Pearsons and Temple 2010). However, competition between steelhead and currently present indigenous species such as redband trout are not assumed to be a major limiting factor since these species historically co-evolved (Hooton and Smith 2008). There are many examples from nearby river systems in the Pacific Northwest that show wild anadromous steelhead and resident rainbow/redband trout can co-exist and maintain abundant populations without adverse consequences. The Deschutes River in Oregon, the Yakima River in Washington, and the river systems in Idaho are examples (NMFS 2006a). As noted by Buchanan et al. (2011a), existing trout and colonizing anadromous steelhead are expected to co-exist in the Klamath Basin, as they do in other watersheds, although there may be shifts in abundance related to competition for space and food. Overall, there is no predicted substantial short-term or long-term decrease in native aquatic species abundance of a year class, or substantial decrease in habitat quality or quantity, and there would not be a significant impact to the aquatic species populations under the Proposed Project in the short term or long term.

Significance

No significant impact for effects to aquatic species from interactions among fish species in the short term and long term

Potential Impact 3.3-19 Effects on freshwater mollusks populations due to short-term sediment releases and long-term changes in habitat quality due to dam removal.

Four species of native freshwater mussels have been observed within the Klamath Basin, including Oregon floater (*A. oregonensis*), California floater (*A. californiensis*), western ridged mussel (*G. angulata*), and western pearlshell mussel (*M. falcata*).Oregon floater and California floater (commonly referred together “floater mussels,” or “*Anodata spp*.”) occur in the mainstem Klamath River in the Hydroelectric Reach, within Lower Klamath Project reservoirs, in a reach (<15 miles) directly downstream of Iron Gate Dam, and within the Upper Shasta River. *M. falcata* are common in the mainstem Klamath River from Iron Gate Dam downstream to the confluence with the Trinity River, and within Middle Klamath tributaries such as Bogus Creek, and Shasta, Scott, and Salmon rivers. *G. angulata* is more widely distributed and more abundant than the other species and has been observed in high densities from Keno Dam downstream to the confluence with the Trinity River, and within the Shasta and Scott rivers (Davis et al. 2013). Mussel abundance also generally declines with increasing distance downstream from Iron Gate Dam, suggesting the effects of the increasing hydrologic variability of the Klamath River with distance from Iron Gate. Davis et al. (2013) concluded that habitats located further downstream had lower probabilities of supporting mussels due to more variable conditions.

Seven to eight species of fingernail clams and peaclams (Family: Sphaeriidae) also occur in the Hydroelectric Reach and from Iron Gate Dam to Shasta River. This evaluation focuses on freshwater mussels because of their similar distribution to other freshwater mollusks, similar habitat requirements, their longer life-span, and lack of information regarding the effects of sediment on clams and other mollusks.

Suspended Sediment Concentrations

Under the Proposed Project, in the Hydroelectric Reach between J.C. Boyle Dam and Copco No.1 SSCs are predicted to exceed 600 mg/L (the minimum SSC level that would be considered detrimental to freshwater mussels), for short periods of time (1–5 days) during spikes in SSCs. SSCs are expected to be higher than under existing conditions and would likely exceed 600 mg/L for two to four months after removing the dams from Copco No 1. Dam downstream to the Klamath River Estuary; however, the highest levels, well in excess of 1,000 mg/L, would occur between Seiad Valley and Iron Gate Dam. Within six months of dam removal SSCs in the mainstem Klamath River are predicted to return to levels observed under existing conditions. Under existing conditions, SSCs in the mainstem Klamath River often exceed 600 mg/L, although these spikes generally occur for a few days as opposed to several months (see also Potential Impact 3.2-3).

Predicted increases in SSC within the Hydroelectric Reach under the Proposed Project are anticipated to result in major physiological stress to *Anodata spp*., and *G. angulata*, including mortality of at least a proportion of the individuals. The most significant impacts would occur downstream from Iron Gate Reservoir, especially to those individual freshwater mussels or freshwater mussel beds upstream of Orleans and closest to Iron Gate Dam. For populations occurring downstream of the confluence with the Salmon River (*M. falcata* and *G. angulata*) dilution from tributaries would limit exposure to SSCs likely to be sublethal. Because freshwater mussels found within the Klamath River can be so long lived (from 10 to more than 100 years, depending on the species) and sexual maturity might not be reached until four years of age or more, even relatively short term (e.g., for more than five consecutive days) SSCs in excess of 600 mg/L, would be expected to be detrimental for freshwater mussel populations within the mainstem Klamath River upstream of the Salmon River confluence, in the short term. This would impact all four-mussel species, most notably *Anodata spp*., due to their limited distribution in the proximity of Iron Gate Dam. *M. falcata* and *G. angulata* are less likely to experience a substantial decline in abundance In the short term, due to their broader distribution downstream of Iron Gate Dam in the mainstem, and strong populations in tributaries.

Freshwater clams can live buried in the substrate, and are expected to suffer less impact than freshwater mussels. In addition, they are relatively short-lived (one to three years) and bear young several times throughout the spring and summer which would support rapid recovery within the short term to impacts from suspended sediment.

In the long term (i.e., greater than five years), it is anticipated that mainstem Klamath *M. falcata* and *G. angulata* populations would rebound from suspended sediment impacts, recolonizing through the transport of larvae (glochidia) by host fish from downstream populations less affected by excessive SSCs or from populations within tributaries, such as Bogus, Shasta, Scott, and Salmon rivers. *Anodata spp*. are anticipated to recover more slowly from suspended sediment impacts, due to a narrower distribution downstream of Iron Gate Dam, and limited distribution within tributaries (i.e., only found in upper Shasta River).

Changes in Bed Elevation

Silt and fine material make up the largest proportion of the volume of sediment stored behind the dams and would be transported downstream primarily as suspended sediment under the Proposed Project. Coarser material (larger than 0.063 mm) would also be transported downstream and would likely be deposited in the river channel, changing riverbed elevations from the existing conditions for approximately eight miles between Iron Gate Dam and Cottonwood Creek. The 182 miles of mainstem downstream from Cottonwood Creek are not predicted to have any substantial aggradation. Therefore, *Anodonta spp*. populations closest to Iron Gate Dam are likely to be most affected by aggradation of sediments under the Proposed Project, whereas *M. falcata* and *G. angulata* with broad distributions are unlikely to be substantially affected. It is not known how well any of these species could tolerate deposition of sediment and whether they could move upward through deposited material to the surface to breathe and feed. It is reasonable to assume that some percentage of Klamath River freshwater mussels buried under 0.5 to 3.0 feet of new sediment would not survive, especially since these same population would be exposed to the increased SSCs described above. *G. angulata* have a demonstrated ability to withstand burial in sediment and are likely to be the least affected.

Freshwater clams can live buried in the substrate and are expected to avoid impacts from bed deposition.

Changes in Bed Substrate

Removal of the Lower Klamath Project dams under the Proposed Project would result in the erosion of accumulated reservoir sediments and changes in substrate characteristics within the Klamath River, especially within the current reservoir reaches. The reformation of river channels in the reservoir reaches is expected to occur within six months (Potential Impact 3.11-5) following removal of the dams. The reformation of river channels between Iron Gate Dam and the upstream reaches of J.C. Boyle Reservoir would benefit *M. falcata* and *G. angulata* and clams in the long term by providing more suitable substrates (i.e., large gravel, cobble, and boulder) than currently exists, especially within the current reservoir reaches. However, conversion of reservoirs to riverine habitat is anticipated to have a short- and long-term impact on *Anodonta spp*., which currently occur within reservoirs, and are adapted to low-flow variability habitat.

Changes in Habitat Accessibility

In addition, the Proposed Project would also open access to river reaches upstream of Iron Gate Dam to migratory fish species, which serve as host fish for parasitic freshwater mussel larvae (glochidia). *M. falcata* in particular may benefit from the increased distribution of anadromous salmonids, which are a primary host species for their larvae. As a result, in the long term suitable habitats upstream of Iron Gate Dam might be colonized or recolonized by all four freshwater mussel species, transported as glochidia from downstream reaches by migratory fish species.

Summary

In the short term, *G. angulata* have a demonstrated ability to withstand burial in sediment and are a widespread and abundant mussel species, including within the Hydroelectric Reach, and within key tributaries upstream and downstream of Iron Gate Dam. Therefore, a relatively small proportion of their population would be directly impacted by sediment released during dam removal. Based on no predicted substantial short-term decrease in *G. angulata* abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the *G. angulata* population under the Proposed Project in the short term.

M. falcata have a broad distribution downstream of Iron Gate Dam in the mainstem, and strong populations in several tributaries in the Middle Klamath River. Therefore, a relatively small proportion of their population would be directly impacted by sediment released during dam removal. Based on no predicted substantial short-term decrease in *M. falcata* abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the *M. falcata* population under the Proposed Project in the short term.

Anodonta spp. would likely be impacted by the Proposed Project due to their close proximity to Iron Gate Dam, and preference for stable flows that currently exist in Lower Klamath Project reservoirs and downstream of Iron Gate Dam. *Anodonta spp*. likely only occurs downstream of Iron Gate Dum under existing conditions as a result of the altered hydrograph (Davis et al. 2013). Under natural conditions they would be unlikely to occur in the mainstem Klamath River downstream. Based on their limited distribution in the mainstem Klamath River, Lower Klamath Project reservoirs, and small presence in the Upper Shasta River, *Anodonta spp*. would likely decline substantially in abundance within the first six months of dam removal as a result of suspended sediment releases. In addition, their habitat would likely substantially decline in quality in the short term. Based on predicted substantial short-term decrease in *Anodonta spp* abundance of a year class, and substantial decrease in habitat quality, there would be a significant impact to the *Anodonta spp* population under the Proposed Project in the short term.

However, the Proposed Project includes aquatic resource measure AR-7 (Freshwater Mussels) to reduce the short-term effects of sediment transport during dam removal on *Anodonta spp*. Aquatic resource measures are summarized in Section 2.7.8.1 *Aquatic Resource Measures* and detailed in Appendix B: *Definite Plan – Updated AR-7, October 2018 Update*. Proposed Aquatic Resource Measure AR-7 includes salvage and relocation plan prior to Lower Klamath Project dam removal and completing a reconnaissance of existing freshwater mussels from Iron Gate Dam to Cottonwood Creek and potential relocation habitat between the upstream extent of J.C. Boyle Reservoir and Keno Dam. Freshwater mussels would be salvaged and relocated in dam removal year 1 prior to the reservoir drawdown. Approximately 15,000 to 20,000 mussels (primarily *Anodonta spp.)* are planned for translocation. There are currently multiple large-scale mussel relocation projects occurring nationwide (Zimmerman et al. 2017, USDA Forest Service 2016, Illinois Department of Natural Resources 2016). Initial findings from these and previous studies indicate that with planning, mussel relocation can be successful. USDA Forest Service (2016) has found that 71 percent of the translocated mussels were found a year later and that only two mussels (0.22 percent) were confirmed dead. Fernandez (2013) found that Between 55 percent and 95 percent of the transplanted *M. falcata* mussels could be accounted for in individual streams one to three years after relocation. Therefore, it appears likely that these measures could be successful. Sites considered for translocation include areas downstream from the Trinity River confluence (RM 43.4), and between J.C. Boyle Dam (RM 230.6) and Copco No. 1 Reservoir (RM 209.0). These areas would have less impact from increased SSCs but would not be completely protected from short-term effects. The areas downstream of the Trinity River confluence do not currently support *Anodonta spp*. and are unlikely to in the future (Davis et al. 2013). The reach between J.C. Boyle Dam and Copco No. 1 Reservoir does not currently support *Anodonta spp.* Therefore, translocation efforts described in proposed Aquatic Resource Measure AR-7 are anticipated to be potentially successful for *G. angulata* and *M. falcata* (based on suitable habitat in translocation sites), but is unlikely to be successful for *Anodonta spp.* With this aquatic resource measure, there would likely still be a substantial reduction in the abundance of *Anodonta spp.* species In the short term, and impacts would be significant with for *Anodonta spp.* in the short term. For development of proposed Aquatic Resource Measure AR-7, the KRRC explored several approaches to salvaging and relocating *Anodonta spp*. prior to dam removal, as described Appendix B: *Definite*

Plan − Updated AR-7, October 2018 Update. However, options such as translocating mussels to tributaries, or other reaches upstream of Iron Gate Dam were rejected after surveys suggesting that most locations would not provide suitable habitat, and the concern of risking healthy and abundant mussels populations in tributaries by translocating mussels from the mainstem reach with unknown disease risk. Therefore, the short-term significant impact on *Anodonta spp*. due to the Proposed Project cannot be avoided or substantially decreased through feasible mitigation.

Freshwater clams can live buried in the substrate and are expected to suffer less impact than freshwater mussels. In addition, they are relatively short-lived (one to three years) and bear young several times throughout the spring and summer which would support rapid recovery within the short term to impacts from suspended sediment. Based on no predicted substantial short-term decrease in freshwater clam abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the freshwater clam populations under the Proposed Project in the short term.

In the long term, dam removal would restore connectivity among the Lower Klamath Basin, the Hydroelectric Reach and its tributaries, and the Upper Klamath Basin, and would rehabilitate and increase availability of riverine habitat within the Hydroelectric Reach for *M. falcata* and *G. angulata*. Based on no predicted substantial long-term decrease in *M. falcata* and *G. angulata* abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the *M. falcata* and *G. angulata* populations under the Proposed Project in the short term.

Conditions would also improve in the long term in the Hydroelectric Reach for *Anodonta spp.* with reduced flow variability downstream of J.C. Boyle Dam, potentially creating conditions more similar to the reach downstream of Keno Dam, where *Anodonta spp*. are currently found (Byron and Tupen 2017). This additional habitat is unlikely to offset the long-term habitat lost from increased flow variability within Lower Klamath Project reservoirs and downstream of Iron Gate Dam. The current populations of *Anodonta spp*. in the Lower Klamath Project reservoirs and downstream of Iron Gate Dam are artifacts of an altered hydrology and geomorphology. The reversion of these conditions to more natural river environment (e.g., natural flow regime and increased sediment scour) would no longer support *Anodonta spp*., and the suitable habitat supporting their populations would be revert to natural spring-fed stable flow conditions, such as the Upper Shasta River. Based on predicted substantial long-term decrease in *Anodonta spp.* abundance of a year class, and substantial decrease in habitat quality and quantity, there would be a significant impact to the *Anodonta spp.* population under the Proposed Project in the long term. Because reversion of the Klamath River within and downstream of the Lower Klamath Project to more natural river conditions would be an inevitable consequence of the Proposed Project, the long-term significant impact on *Anodonta spp*. due to the Proposed Project cannot be avoided or substantially decreased through feasible mitigation.

Based on no predicted substantial long-term decrease in freshwater clam abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to the freshwater clam populations under the Proposed Project in the long term.

Significance

No significant impact for *M. falcata* and *G. angulata* in the short or long term

Significant and unavoidable impact for *Anodonta spp.* in the short and long term

No significant impact for freshwater clams in the short or long term

Potential Impact 3.3-20 Effects on fish species from alterations to benthic macroinvertebrates due to short-term sediment releases and long-term changes in habitat quality due to dam removal.

Benthic macroinvertebrates (BMI) are small aquatic animals and the aquatic larval stages of insects. BMI are the primary food source for most freshwater fish species, and therefore, changes in abundance, distribution, or community structure can affect fish populations. A diminished food supply can limit growth of salmonids, and this is especially true at higher temperatures because as water warms, a fish's metabolic rate increases, and it needs more food to sustain growth. Growth is critical to juvenile salmonids because a larger size fish often has a survival advantage during the overwintering period, smolt outmigration, and ocean residence.

In the short term, the Proposed Project could alter SSCs and bedload sediment transport and deposition and thereby negatively affect benthic macroinvertebrates. Increases in suspended sediment and increased bedload deposition following dam removal under the Proposed Project are anticipated to result in a reduction in abundance of BMIs within the first few months of dam removal year 2 in the reach from Iron Gate Dam to confluence with the Salmon River, and SSC increases may decrease growth rates of fish rearing and feeding in the mainstem Klamath River downstream of Iron Gate Dam to around the Salmon River confluence. Short-term reductions in the abundance and diversity of BMIs has been observed following disturbance due to suspended sediment (Reid and Anderson 2000, Orr et. al 2008). During the period of greatest impact (winter of sediment release dam removal years 1 and 2), food availability related to BMI production would likely decrease in the reach downstream of Iron Gate Dam around the confluence with the Salmon River. However, within this reach a reduction in feeding by fish species is already predicted to occur in response to increased SSCs, which is a sub-lethal effect from which fish populations are anticipated to recover. In addition, salmonids typically reduce feeding during winter in response to lower water temperature and decreased metabolic demand (Bustard and Narver 1975).

While a large proportion of the BMI population in the Hydroelectric Reach and in the mainstem Klamath River downstream from Iron Gate Dam would be reduced in the short term, their populations would be expected to recover quickly because of the many sources for recolonization and their rapid dispersion through drift or aerial movement of adults. Full recovery of BMI communities is typically observed within a year following disturbance (Tsui and McCart 1981, Anderson et al. 1998). The constant "flushing" action of the Klamath River is anticipated to speed BMI recovery from negative impacts resulting from sediment deposition. Tullos et al. (2014) found that BMI communities downstream of the Brownsville (Calapooia River, Oregon) and Savage Rapids (Rogue River, Oregon) dams resembled upstream control sites within a year after dam removal. Foley et al. (2017) summarizes the effects of multiple dam removal studies and found that researcher reported that following dam removal downstream BMI abundance tends to increase and species assemblages transition to resemble sites upstream of the former dam, noting that some BMI species can double their population size in days to weeks, and quickly (within months) recover once the initial sediment pulse has passed. There, the effects of reduced BMI populations on food availability for fish species is anticipated to be of insufficient magnitude or duration to substantially effect fish species in the short term. Based on no predicted substantial short-term decrease in fish abundance of a year class, or substantial decrease in habitat quality or quantity supporting a fish species, there would not be a significant impact to fish populations under the Proposed Project in the short term from effects to BMIs.

In the long term, the Proposed Project would restore connectivity among the Lower Klamath Basin, the Hydroelectric Reach and its tributaries, and the Upper Klamath Basin, and would rehabilitate and increase availability of riverine habitat within the Hydroelectric Reach. The reformation of river channels in the reservoir reaches upstream of Iron Gate Dam, and the reversion to unimpeded sediment transport downstream of Iron Gate Dam under the Proposed Project, would benefit BMIs by providing more suitable substrates (e.g., gravel) than currently exist. Thus, suitable habitats formed upstream of Iron Gate Dam might be opened to additional colonization by BMIs through rapid dispersal by drift from upstream populations within current riverine reaches and/or dispersion of adult life stages. In addition, recolonization would occur rapidly from established BMI populations within the many tributary rivers and streams of the Klamath River. BMI populations would be expected to recover quickly and provide food availability to fish from short-term impacts because of the many sources for recolonization and their rapid dispersion through drift or aerial movement of adults.

Under the Proposed Project, peaking operations would no longer kill, through stranding, large numbers of aquatic invertebrates that are the primary prey food for resident trout in the reach between J.C. Boyle Powerhouse and Copco No. 1 Reservoir (NMFS 2006a). Based on increased habitat availability and improved habitat quality, the effect of the Proposed Project on BMI as a food source for fish species would be beneficial in the long term. Based on no predicted substantial long-term decrease in fish abundance of a year class, or substantial decrease in habitat quality or quantity supporting a fish species, there would not be a significant impact to fish populations under the Proposed Project in the long term from effects to BMIs.

Significance

No significant impact for effects of alterations to benthic macroinvertebrates on fish species in the short term

Beneficial for effects of alterations to benthic macroinvertebrates on fish species in the long term

Potential Impact 3.3-21 Effects on aquatic resources due to short-term noise disturbance and water quality alterations from construction and deconstruction activities.

This analysis relates to the potential impact to aquatic resources from various construction and deconstruction activities associated with the Proposed Project, outside of the release of reservoir sediments discussed more thoroughly above, and the relocation of the City of Yreka's water supply pipeline, discussed below as Potential Impact 3.3-23.

Disturbance to the river channel during construction related to the Proposed Project could affect aquatic species. The Proposed Project would require demolition of the dams and their associated structures, removal of power generation facilities and transmission lines, installation of cofferdams, road upgrading, hauling, reservoir restoration, and other activities (as described in Section 2.7.1 *Dam and Powerhouse Deconstruction*). These actions would include the use of heavy equipment, and blasting as necessary, and have the potential to disturb aquatic species. Activities at the Lower Klamath Project dams would affect the riverine and introduced resident species in the Hydroelectric Reach. At Iron Gate Dam and Iron Gate Hatchery, anadromous species could also be affected. These potential effects could include shockwaves associated with breaking down the dam structures using explosives or heavy equipment, potential crushing of aquatic species from operation of heavy equipment in the river, sedimentation, and release of oil, gasoline, or other toxic substances from construction sites.

Several deconstruction activities are schedule to occur prior to reservoir drawdown, including road improvements (e.g., bridge upgrades), temporary road crossings, Iron Gate modifications, Fall Creek Hatchery modifications, etc. In-water demolition of the dams and their associated structures, power generation facilities, and other activities, are scheduled to occur nearly simultaneously within the first nine months of reservoir drawdown during dam removal year 2 (see Table 2.7-1), and during the peak SSCs associated with reservoir drawdown in dam removal year 2. The aquatic resources impacts of this reservoir drawdown SSC peak are discussed earlier in this section. It is anticipated that this release of sediment during initial drawdown would result in the nearly immediate displacement of most mobile aquatic species from the mainstem into tributaries or farther downstream prior to the prolonged deconstruction or in-water work activities (e.g., cofferdam installation or removal). Native aquatic species (e.g., redband trout) that occur in the Hydroelectric Reach would have less potential refuge in the mainstem from deconstruction impacts, but would have access to key tributaries as refigure, including Jenny, Fall, and Shovel creeks. For non-mobile aquatic resources, like mussels, the impacts are anticipated to be well within the range of what is discussed for reservoir sediment release, as it is assumed that construction and deconstruction-related impacts would be of small magnitude, short duration, and low intensity when compared to those that would occur as a result of release of sediments stored behind the dams.

For aquatic species that occur within reservoirs, the effect of deconstruction is already subsumed by the impact of conversion of reservoir to riverine habitat, as described in multiple potential impacts above. For example, the reservoir habitat that supports Lost River and shortnose suckers (Potential Impact 3.3-13) would be removed, as addressed by the Aquatic Resource Measure AR-6 to salvage and relocate suckers prior to reservoir drawdown, or impacts associated with deconstruction.

To minimize potential construction impacts from crushing, sediment release, toxins, noise, etc., construction areas would be isolated from the river where possible. The Klamath River would be bypassed around the construction area while the isolated portion of the dam is removed. After a work area is isolated, fish rescue and relocation efforts, to remove any native fish trapped in the work area, would be conducted. Fish would be relocated to an area of suitable habitat within the Klamath River.

In addition, proposed soil erosion and sedimentation control and stormwater pollution prevention (Section 2.7.8.7 *Water Quality Monitoring and Construction BMPs*) measures would minimize effects of construction related toxins, soil erosion, and associated water quality effects on aquatic species downstream from the work area, during and after construction. Further, the State Water Board has issued a draft water quality certification which sets forth multiple conditions to monitor the effects of deconstruction on water quality (e.g., suspended sediment, dissolved oxygen, toxicity, etc.), and to protect aquatic resources through proper disposal of materials. Based on no predicted substantial short- or long-term decrease in aquatic species abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to aquatic resources under the Proposed Project in the short term or long term from deconstruction effects.

Significance
No significant impact for aquatic resources from deconstruction in the short term or long term

Potential Impact 3.3-22 Effects on aquatic species due to short-term noise disturbance and water quality alterations from deconstruction activities and long-term fish screen upgrades from the relocation of the City of Yreka Water Supply Pipeline under the Proposed Project.
The existing water supply pipeline for the City of Yreka passes under the upstream end of Iron Gate Reservoir and would have to be relocated prior to decommissioning the Iron Gate Dam to prevent damage from deconstruction activities or increased water velocities and pipeline exposure once the reservoir has been drawn down. Additionally, the water supply intake screens located in Fall Creek may need to be replaced or upgraded to meet regulatory criteria. Native species currently residing in Iron Gate Reservoir that could be affected from the construction-impacts of removal of the existing pipeline and the installing of a new one in the short term would include redband trout, cutthroat trout, chub species, sucker species, and sculpin species. In the long term anadromous fish accessing habitat upstream of Iron Gate Dam could also be affected by improved screens at the water supply intakes. If the existing fish screens for the water supply intakes do not meet current regulatory agency screen criteria for anadromous fish, improved screened intakes presumably would meet criteria. As described in Section *2.7.8.7 Water Quality Monitoring and Construction BMPs,* standard construction best management practices would reduce the likelihood and extent of aquatic impacts to a less-than-significant level for water quality purposes. These levels are set for protection of aquatic resources. Therefore, based on no predicted substantial short- or long-term decrease in aquatic species abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to aquatic resources under the Proposed Project in the short term or long term from the relocation of the City of Yreka water supply pipeline and intake screens.

Significance
No significant impact to aquatic resources from the relocation of the City of Yreka water supply pipeline and intake screens in the short or long-term

Potential Impact 3.3-23 Effects on anadromous salmonid populations due to short-term and long-term Bogus Creek flow diversions for the Iron Gate Hatchery.
Under the Proposed Project, up to 8.75 cfs of water would be diverted from Bogus Creek to operate Iron Gate Hatchery for eight years (dam removal year 2 through post-dam removal year 7), as described in Section 2.7.6 *Hatchery Operations*. This diversion would replace the current water supply from Iron Gate Reservoir. Specific diversion rates from Bogus Creek would be as follows:

- 6.50 cfs October through November
- 8.75 cfs in December
- 3.50 cfs January through March
- 8.25 cfs April through May
- 0.00 cfs June through September

To reduce the potential adverse effects of diverting water from Bogus Creek on naturally spawning and rearing salmon, the KRRC proposes to construct the pump station for the hatchery water supply would be constructed as far downstream toward the Klamath River confluence as practicable (within 1,000 feet, Figure 2.7-10). This would result in up to a 1,000-foot reach in lower Bogus Creek that would experience lower fall, winter, and spring flows than under existing conditions (Figure 2.7-11). As further discussed below, CDFW and NMFS have proposed monitoring and adaptation of operations to minimize habitat impacts.

Based on adult migrant monitoring (Knechtle and Chesney 2011, 2016, 2017), fall-run Chinook salmon are observed to return to Bogus Creek to spawn from mid-September to early November, coho salmon adults return from late October to early January, and steelhead from November through March. Therefore, flow diversions of 6.5 cfs during October and November, and 8.75 cfs in December could affect upstream migration of adult salmonids into Bogus Creek through the lower reach. The volume of flow required for adult salmonids to migrate upstream through lower Bogus Creek has not been directly assessed. Depending on stream gradient, channel width, and other geomorphic conditions, flows below the diversion may continue to be sufficient for upstream passage, or they could result in conditions that restrict passage at times, particularly in early October prior to increased precipitation. The geomorphic conditions that determine passage are subject to change as precipitation events alter the streambed.

Based on two years of recent migration observations in Bogus Creek (Knechtle and Chesney 2016, 2017) during the low flow years of 2015 and 2016, fall-run Chinook salmon were observed migrating at flows as low as 4.5 cfs in September 2016, and 8 fish were observed migrating at flows between 4.5 and 5 cfs. During the fall-run Chinook salmon migration peak in 2015 and 2016, flows were between 10 and 20 cfs. Based on this data, flows greater than around 4.5 cfs enabled at least some upstream migration in the past. If this flow was sufficient for Chinook salmon, it would also be sufficient for coho salmon and steelhead, which have less restrictive passage requirements. Long-term flow monitoring data are not available for Bogus Creek. However, the available data from 2013–2016 includes severe and extreme drought conditions and are therefore likely appropriate to observe minimum flows to support passage. Based on four years of available data (Figure 2.6-8), proposed water diversions could result in flow reductions during the adult migratory period of around 10 to 40 percent in the affected reach during fall-run Chinook salmon migration, potentially resulting in flows less than 4.5 cfs in at least some years, for at least a few days. By the time coho salmon and steelhead are migrating flows are high enough to provide greater than 4.5 cfs, based on the data available. Based on available data it appears that under the Proposed Project insufficient flows for Chinook salmon passage could result in delays for up five days in some years. Delay of migration for even one day has been observed to increase disease risk by increasing the density of holding adults and increasing mortality of adults prior to spawning (McLaughlin et al. 2012, Connor et al. 2018). Temporary increasing in crowding may be similar to similar to what is observed under existing conditions during periods of low rainfall, but could be exacerbated by decreasing flows in lower Bogus Creek. These impacts are anticipated to effect a small proportion of migrants during the 14-week fall-run Chinook salmon migration period (Table 3.3-3). In addition, any redds that are deposited along channel margins (shallow water areas) downstream of the diversion may be susceptible to stranding when diversion rates increase (e.g., primarily December, as well as March), although the affected reach is relatively short (< 1,000 feet). Rearing fish (mobile) are unlikely to be affected by the relatively low magnitude of flow fluctuations.

As described in detail in Section 2.7.6 *Hatchery Operations*, the proposal for Iron Gate Hatchery operation includes protection for fish passage in Bogus Creek (Appendix B: *Definite Plan – Section 7.8.3*, NMFS and CDFW 2018). To minimize effects of Bogus Creek diversions on fish habitat, NMFS and CDFW would coordinate to ensure that at least 50 percent of the flow would remain in Bogus Creek at the point of diversion, conduct an assessment to determine that the habitat below the diversion provides connectivity for fish spawning and rearing habitat, identify appropriate flow levels or percentages of diversion permitted each month, and establish reporting specifications (Section 2.7.6 *Hatchery Operations*).

Based on the potential for low flows (i.e., less than 4.5 cfs) in the Bypass Reach during the salmonid migration periods in some years resulting in delayed migration and increased crowding, the uncertainty in the migration flow levels in Bogus Creek, and the uncertainty in the commitment to ensure flows to protect anadromous salmon volitional migration, the flow diversions from Bogus Creek could decrease the abundance of multiple (up to eight) year classes of anadromous salmonids produced from spawning activity in Bogus Creek. However, only a portion of the fall-run migration could be affected, and the total potential production from redds in Bogus Creek is a low proportion of all the production from the Klamath River Basin for Chinook salmon, coho salmon, and steelhead. Based on the less than substantial decrease in abundance of a year class and habitat quality that could occur under the Proposed Project in the short- and long-term, the effect of reduced instream flows in Bogus Creek under the Proposed Project would not be significant in the short- and long-term.

Although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, Mitigation Measure AQR-3 would even further reduce the potential for short- and long-term effects of reduced instream flows in lower Bogus Creek under the Proposed Project on anadromous salmon by increasing certainty that fish passage conditions are projected. Mitigation Measure AQR-3 below includes additional components beyond those listed as part of the Proposed Project which would further reduce the potential short-term impacts on migrating anadromous salmonids resulting from hatchery operations. With Mitigation Measure AQR-3, the potential effect of instream flow diversions is further reduced.

Mitigation Measure AQR-3 – Bogus Creek Flow Diversions.
Implementation of Iron Gate Hatchery operations plan (Described in Appendix B: *Definite Plan – Section 7.8.3*) shall include a minimum flow in Bogus Creek of 4.5 cfs, unless a study is conducted that determines an alternative minimum flow is required to provide volitional fish migration for Chinook salmon, coho salmon, and steelhead. If the hatchery diversions cause a flow within Bogus Creek downstream of the bypass that is less than 4.5 cfs (or the minimum flow identified for each species during their migration

period), then hatchery operations shall be adjusted, in coordination with NMFS and CDFW, to reduce the percentage of flow diverted from Bogus Creek to be protective of anadromous fish passage.

Significance

No significant impact with mitigation on Chinook salmon, coho salmon, or steelhead in the short term or long term

Potential Impact 3.3-24 Effects on anadromous salmonid populations due to short-term and long-term Fall Creek flow diversions for the Fall Creek Hatchery .

Under the Proposed Project, up to 9.24 cfs of water would be diverted from Fall Creek to operate Fall Creek Hatchery for eight years (through post-dam removal year 7), as described in Section 2.7.6 *Hatchery Operations*. Specific diversion rates from Fall Creek would be as follows:

- 8.48 cfs in October
- 9.24 cfs in November
- 6.32 cfs in December
- 5.77 cfs in January
- 1.47 cfs in February
- 1.76 cfs in March
- 1.84 cfs in April
- 1.08 cfs in May
- 0.58 cfs in June
- 1.01 cfs in July
- 1.48 cfs in August
- 2.29 cfs in September

In addition, the City of Yreka maintains a water right to divert up to 15 cfs from Fall Creek for municipal purposes (City of Yreka 2012). The primary water intake for this water pipeline is located along the PacifiCorp Fall Creek powerhouse return canal at Dam A (Figure 2.7-17), which is upstream of the proposed Fall Creek Hatchery water diversion. Under the Proposed Project no fish passage would be possible past the existing Dam A or Dam B on Fall Creek (Figure 2.7-8; Appendix B: *Definite Plan – Section 7.8.3*), approximately one mile upstream from the projected confluence of Fall Creek with the Klamath River. Depending on final site selection, discharge from the hatchery would re-enter Fall Creek from between 0.08 and 0.36 miles upstream from the confluence with the Klamath River. Therefore, most of the one mile of spawning and rearing habitat for salmonids in Fall Creek, from Dam A and Dam B to the confluence with the Klamath River, would be subject to reduced flows as a result of Fall Creek Hatchery water diversions.

Based on historical records and current assessments of habitat suitability, Fall Creek likely has the potential to provide around one mile of spawning and rearing habitat for fall-run and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey following the removal of the fish passage barrier of Iron Gate Dam (NMFS 2006a, Hamilton et al. 2005, 2011).

The City of Yreka is required to bypass a minimum flow of 15 cfs or the natural flow of Fall Creek, whenever the natural flow is less than 15 cfs. Under existing conditions Yreka uses less than the 15 cfs allocation, but the City has used the full allocation in the past, and for this analysis it is assumed that the City of Yreka would use their full water right of up to 15 cfs. The Fall Creek Hatchery diversion and return flow points would occur between the City of Yreka water supply intake and the City's compliance point for the Fall Creek minimum flow, which is at the Fall Creek USGS gage (USGS No. 11512000). Between the Fall Creek Hatchery diversion and return flow points, the flow remaining in Fall Creek after the diversions for the City of Yreka and the Fall Creek Hatchery would usually be greater than 15.0 cfs, but it could occasionally be slightly less than 15.0 cfs in late summer to early fall (i.e., mid-July to mid-September) when natural Fall Creek flows reach a minimum. Fall Creek Hatchery diversion flows during the late summer would be 1.01 to 2.29 cfs, potentially reducing flows within the hatchery diversion affected reach to less than 15 cfs in dry water years with particularly low flows. However, this slight reduction during late summer is not anticipated to have a substantial effect on habitat availability or fish passage, due to the volume of instream flows remaining in the reach. During periods of the year when hatchery diversions would be higher (e.g., October through January), typically flows greater than 20 cfs would occur in this section of Fall Creek (Figure 2.7-13), which based on the habitat and channel morphology in Fall Creek is anticipated to provide suitable migratory, rearing, and spawning conditions. Any redds that are deposited downstream of the diversion along channel margins (shallower water) during fall may be susceptible to stranding (i.e., reduced egg-to-emergence survival) when diversion rates increase (e.g., primarily October and November). Rearing fish (mobile) are unlikely to be affected by the relatively low magnitude of flow fluctuations.

Under the Proposed Project anadromous salmonids would have increased habitat access upstream of Iron Dam, including within around one mile of habitat within Fall Creek that is currently inaccessible. Overall, a relatively small diversion of water from Fall Creek relative to existing creek flows would occur under the Proposed Project. In addition, the proportion of anadromous salmonids anticipated to use the habitat in Fall Creek is relatively minor in comparison with the totality of newly accessible habitat upstream of Iron Gate Dam under the Proposed Project. Therefore, based on no predicted substantial short- or long-term decrease in anadromous salmonid population abundance of a year class, or substantial decrease in habitat quality or quantity, there would not be a significant impact to anadromous salmonids under the Proposed Project in the short term or long term from Fall Creek Hatchery flow diversions.

Significance

No significant impact on Chinook salmon, coho salmon, or steelhead in the short term or long term

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3.4 Phytoplankton and Periphyton

This section focuses on potential effects of the Proposed Project on the phytoplankton and periphyton communities in the Klamath River. For the purposes of this EIR the following terms have the following meanings:

- Phytoplankton: aquatic microscopic organisms, including algae, bacteria, protists, and other single-celled plants, that obtain energy through photosynthesis and float in the water column of still or slowly flowing waters such as lakes or reservoirs.
- Periphyton: aquatic organisms including aquatic plants, algae, and bacteria that live attached to underwater surfaces such as rocks on a riverbed.
- Algae: common name for photosynthesizing organisms that are a component of phytoplankton and/or periphyton (see above definitions) where algae typically include diatoms, green algae, and blue-green algae.
- Blue-green algae: common name for a type of phytoplankton that can produce toxic compounds that have harmful effects on fish, shellfish, mammals, bird, and people. Though blue-green algae are a type of cyanobacteria they are commonly referred to as algae. Cyanobacteria toxins are often referred to as "algal toxins". For readability, and to reduce confusion, this EIR will primarily refer to cyanobacteria as blue-green algae, with the exception of referencing source material.

In a balanced ecosystem, phytoplankton and periphyton supply base energy for the food web, because they convert energy from the sun (through photosynthesis) into biomass. In addition to sunlight, water and air, phytoplankton and periphyton also rely on nutrients from the water (primarily nitrogen and phosphorus). An excessive nutrient load in the water can allow phytoplankton and periphyton to overwhelm the ecosystem, causing negative impacts to water quality and other environmental resources. In addition to water quality and environmental impacts, blue-green algae can produce toxic compounds that have harmful effects on fish, shellfish, mammals, birds, and people.

The State Water Board received several comments related to blue-green algae during the NOP public scoping process (Appendix A), including comments indicating that dam removal would reduce the incidence of blue-green algae blooms and associated toxins in the Klamath River system. Commenters related numerous instances in which they linked health impacts to water contact in the presence of blue-green algae toxins, and they described having to limit recreation and avoid water contact due to blue-green algae despite the cultural importance of the river. Several commenters also noted that they no longer eat fish from the Klamath River due to concerns about consuming blue-green algae toxins with the fish. Other comments indicated that blue-green algae growth would continue to occur in the Klamath River in the absence of the Lower Klamath Project reservoirs. There were also several comments regarding periphyton, suggesting that dam removal would reduce the prevalence of attached algae in the Klamath River, which could reduce parasite rates in anadromous fish. A detailed summary of comments received during the NOP public scoping process, as well as individual comments, are presented in Appendix A.

Discussion of blue-green algae toxins and their impact on water quality are addressed in Section 3.2 *Water Quality*. Discussion of the relationship between periphyton and fish disease is addressed further with respect to aquatic organisms in Section 3.3.2.3.5 *Disease and Parasites*. Discussion of blue-green algae and its impact on recreation are addressed in Section 3.20 *Recreation*. Discussion of tribal cultural resources impacts of blue-green algae are addressed in Section 3.12 *Historical Resources and Tribal Cultural Resources* and Appendix V to this EIR.

3.4.1 Area of Analysis

The Area of Analysis for phytoplankton and periphyton includes multiple reaches of the Klamath River, as listed below and shown in Figure 3.4-1.

Upper Klamath Basin

- Hydroelectric Reach (upstream end of J.C. Boyle Reservoir to Iron Gate Dam)

Mid-Klamath Basin

- Klamath River from Iron Gate Dam downstream to the confluence with the Salmon River
- Klamath River from the confluence with the Salmon River to the confluence with the Trinity River

Lower Klamath Basin

- Lower Klamath River from the confluence with the Trinity River to the Klamath River Estuary
- Klamath River Estuary
- Pacific Ocean nearshore environment

Note that the portion of the Hydroelectric Reach that extends into Oregon (i.e., from the Oregon-California state line [RM 214.1] to the upstream end of J.C. Boyle Reservoir) is only being considered in this chapter to the extent that conditions in this reach influence phytoplankton and periphyton communities downstream in California.

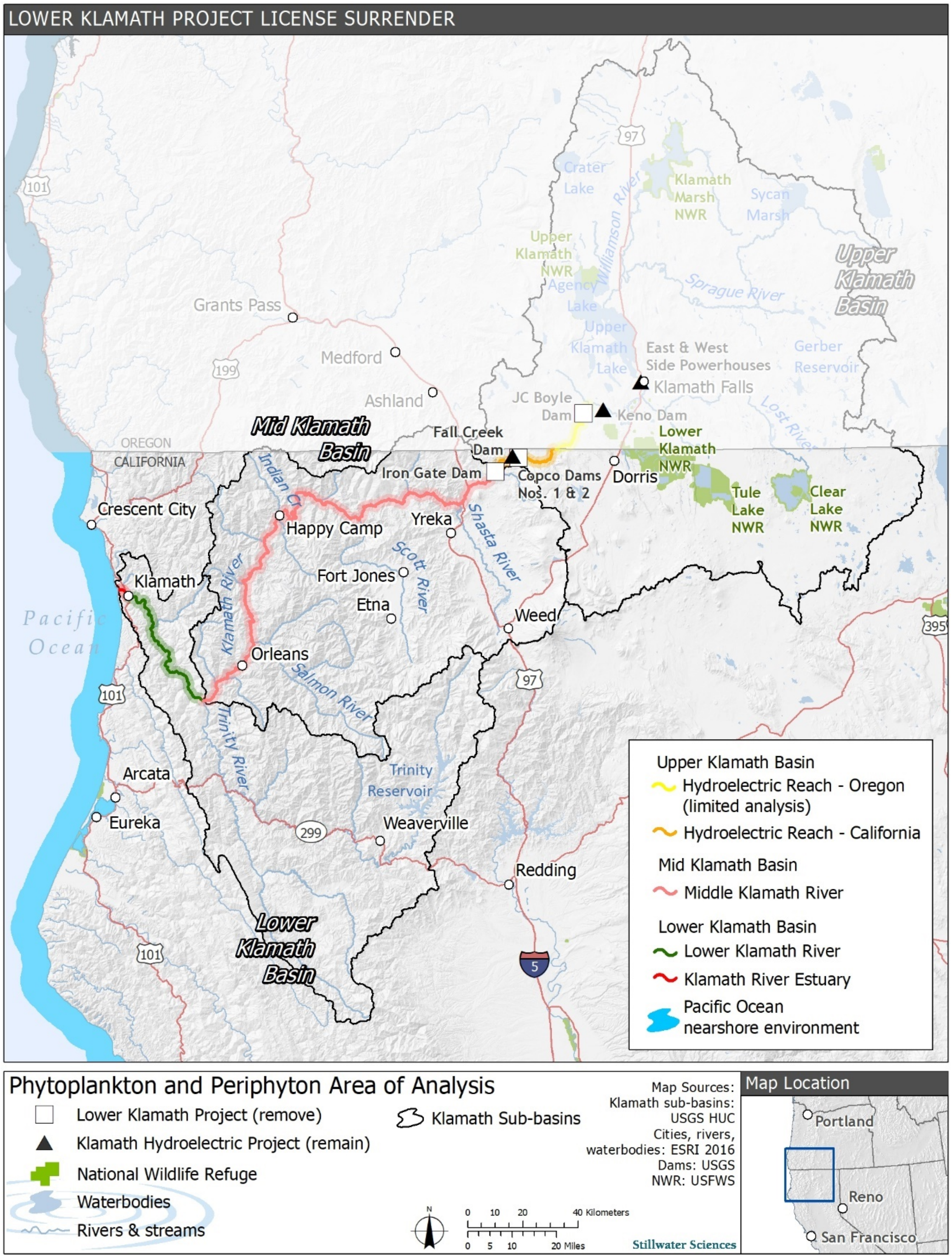

Figure 3.4-1. Klamath River Reaches Included in the Area of Analysis for Phytoplankton and Periphyton.

3.4.2 Environmental Setting

Phytoplankton and periphyton (defined in bullets at the beginning of in Section 3.4) are the two primary groups of algae (i.e., algal communities) in the Area of Analysis. Phytoplankton, including blue-green algae, compose the majority of the algal community in the reservoirs since phytoplankton prefer relatively still water. In the Klamath Basin, blue-green algae frequently reach nuisance levels within Upper Klamath Lake, Copco No. 1 Reservoir, and Iron Gate Reservoir. In addition, blue-green algae can be found in portions of the Klamath River (e.g., backwater eddies and near shore shallows) where blue-green algae cells from upstream lakes and the Lower Klamath Project reservoirs have drifted downstream. These portions of the river can also support nuisance levels of blue-green algae under certain conditions. Typically, most of the riverine portions of the Klamath River are dominated by periphyton, which include diatoms, green algae, fungi, and bacteria that attach to the stream bed and/or other underwater surfaces. Larger aquatic plants may also be present in quiet backwater areas in the Klamath River; however, no known quantitative or species-specific information about these plants has been collected in the phytoplankton and periphyton Area of Analysis. Since no surveys have been conducted to determine the relative distribution or biomass[100] of large aquatic plants in the Klamath River, they are not discussed further in this section. Wetland and riparian habitat, along with associated plant species, are discussed in Section 3.5 *Terrestrial Resources*.

3.4.2.1 Phytoplankton

A number of different groups of organisms contribute to the phytoplankton communities in the Klamath River and mainstem reservoirs, including diatoms, green algae, and blue-green algae. The composition of the phytoplankton communities shifts seasonally in response to changing temperature, light, and nutrient levels. Phytoplankton form the base of the food web in lakes and reservoirs throughout the world; they are consumed by zooplankton, insects, and some small fish, which are fed upon by larger fish, birds, mammals, and humans. Diatoms and green algae are generally considered to be beneficial components of phytoplankton communities based on their important role supplying nutrients to the food web. When phytoplankton communities reach high concentrations in the water column (e.g., greater than 10 to 15 micrograms per liter [ug/L] of water), the species composition often shifts from the more beneficial green algae species to nuisance blue-green algae species. The shift in species composition can happen quickly (i.e., in days) due to blue-green algae's relatively fast reproductive rates.

At high biomass levels, phytoplankton can create nuisance water quality conditions. A primary driver of nuisance conditions is extreme diel (daily) fluctuations in dissolved oxygen and pH due to the process of photosynthesis (the consumption of carbon dioxide and waste production of oxygen) and cellular respiration (the consumption of oxygen and waste production of carbon dioxide). During daylight hours, phytoplankton use sunlight to conduct photosynthesis, increasing the dissolved oxygen concentrations in water. Photosynthesis stops in the evening when sunlight is not available. During the night, cellular respiration consumes dissolved oxygen and results in decreases in dissolved oxygen concentrations in the water column. During both daylight and evening hours, dead and decaying phytoplankton are consumed by aerobic bacteria, using

[100] The total mass of organisms in a given area or volume.

dissolved oxygen from the water column and at times contributing to decreases in dissolved oxygen levels below those sufficient to support aquatic organisms (e.g., fish). The pH of water fluctuates with daily variations in photosynthesis and respiration. Photosynthesis consumes carbon dioxide in the water, such that when photosynthesis dominates during the day the pH increases. Cellular respiration releases carbon dioxide that, in contact with water, forms carbonic acid, decreasing the pH during the evening. Microbial decomposition of dead phytoplankton can also release free ammonia into the water column as cellular nitrogen is converted into ammonia, especially after a bloom when a high concentration of dead phytoplankton cells is being decomposed. Variations in dissolved oxygen, pH, and ammonia due to phytoplankton are primarily driven by the availability of sunlight and the resulting variations in the amount of photosynthesis and respiration. As more sunlight is available during summer months, there is generally more for photosynthesis at this time of year and a higher potential for larger variations in dissolved oxygen and pH in lakes, reservoirs, and rivers. In addition to dissolved oxygen, pH, and at times ammonia, high concentrations of blue-green algae species, such as *Anabaena flos-aquae* and *Microcystis aeruginosa,* can produce nuisance levels of algal toxins (e.g., anatoxin-a and microcystin) that are harmful to fish, mammals, and humans (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*).

The stable lacustrine[101] environment created by Copco No. 1 and Iron Gate dams, coupled with high nutrient availability and high water temperatures in summer and fall months, provides ideal conditions for phytoplankton growth, especially the growth of blue-green algae species (Figure 3.4-2 and Figure 3.4-3). While cyanobacteria [blue-green algae] can be found in a variety of lake, reservoir, river, and estuarine environments, the cyanobacteria [blue-green algae] species *Anabaena flos-aquae* and *Microcystis aeruginosa* thrive in warm, high nutrient, and stable water column conditions (Konopka and Brock 1978; Kann 2006; Asarian and Kann 2011), where they can out-compete other beneficial algae species such as diatoms and green algae (Visser et al. 2016). While they do not thrive in fast-moving water, diatoms and green algae do not regulate their buoyancy, and thus they rely on mixing in the water column (e.g., from wind, convection, or slow currents) to remain suspended near the water surface where light is available for photosynthesis. In reservoirs with warm water and a stable water column, diatoms and green algae tend to settle out of the water column away from sunlight. Cyanobacteria [blue-green algae] cells contain gas sacs (vesicles[102]), so they can control their buoyancy and remain near the water surface to obtain light for photosynthesis (Walsby et al. 1997). The ability to control their density and position in the water column gives blue-green algae better access to light and they can shade phytoplankton lower in the water column. Thus, blue-green algae are able to outcompete diatoms and/or green algae under lower mixing conditions in reservoirs. *Microcystis aeruginosa* can dominate the phytoplankton community in calm, stable lacustrine conditions, when their ability to float exceeds the rate of turbulent mixing in the water column (Huisman et al. 2004). However, blue-green algae abundance in the phytoplankton community decreases compared to diatoms and green algae when water column mixing in a water body increases (McDonald and Lehman 2013; Visser et al. 2016).

[101] Pertaining to a lake, reservoir, or other calm water types.
[102] A small bubble-like hollow sac within a cell made of rigid proteins and filled with gas (Walsby 1994).

Figure 3.4-2. Dense summer and fall blue-green algae bloom in Iron Gate Reservoir with higher concentrations of blue-green algae occurring along the shoreline of the reservoir in slower moving water. Photo courtesy of the Karuk Tribe. Source: NMFS 2012.

Figure 3.4-3. Blue-green algae bloom along the Copco No. 1 shoreline on 7/13/2005. Source: Kann and Corum 2006.

As discussed above, blooms of floating algae (i.e., phytoplankton) can have negative impacts on water quality related to daily fluctuations in dissolved oxygen, pH, and nutrients such as ammonia. In the Klamath River, nuisance water quality conditions associated with phytoplankton are dominated by blooms of cyanobacteria [blue-green algae] species for both reservoir (Copco No. 1 and Iron Gate) and river portions of the Klamath River, particularly in the summer months (Asarian and Kann 2011; Gibson 2016). Within the phytoplankton and periphyton Area of Analysis, blue-green algae productivity is locally and seasonally associated with extreme daily fluctuations in dissolved oxygen levels (high during the day and low at night), elevated pH (above 8 s.u.), and free ammonia concentrations. Blue-green algae have a high cellular nitrogen content, so microbial decomposition of dead blue-green algae after a bloom can generate a relatively high amount of free ammonia and result in a further decrease in the water column's pH. Multiple reaches of the Klamath River from the Oregon-California state line to the Klamath River Estuary are included on the Clean Water Act (CWA) Section 303(d) list of water bodies with water quality impairments for water temperature, organic enrichment/dissolved oxygen, nutrients, and microcystin concentration (USEPA 2010) (Table 3.2-3). Organic enrichment and dissolved oxygen depressions are particularly problematic during the summer and fall months when water temperatures are relatively high.

Nuisance and/or noxious algal blooms that occur in the phytoplankton and periphyton Area of Analysis are primarily composed of three species of blue-green algae: *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, and *Microcystis aeruginosa*. While these blue-green algae species are a natural part of aquatic systems in California, including the Klamath River, environmental conditions that favor the growth and bloom of these blue-green algae species have been created by human modifications to the Klamath River (e.g., dams on the Klamath River that form slow-moving or stagnant water and additional inputs of nutrients above natural conditions). Blooms of these blue-green algae species can cause water quality and human health concerns because these species have been associated with the release of algal toxins (State Water Board et al. 2010, updated 2016).

Aphanizomenon flos-aquae

Aphanizomenon flos-aquae is a filamentous (thread-like), nitrogen-fixing cyanobacteria [blue-green algae] that is common in the Klamath Basin, especially in Upper Klamath Lake where it can comprise more than 90 percent of blue-green algae bloom biovolume (Figure 3.4-4 and Figure 3.4-5; Kann 1997; Eldridge et al. 2012). Nitrogen fixation is a cellular process where nitrogen gas in the air is converted into a biologically useful form of nitrogen for cellular growth. *Aphanizomenon flos-aquae* can thus provide its own source of nitrogen for algal growth, giving it a competitive advantage over non-nitrogen fixing algae species when phosphorus is abundant, but nitrogen is not. *Aphanizomenon flos-aquae* accounted for approximately 39 percent of the total phytoplankton biovolume measured between June and November 2007 at 21 sites in the Klamath Basin from the Upper Klamath Lake to Turwar, including Copco No. 1 and Iron Gate reservoirs (Raymond 2008). In a study of phytoplankton abundance at nine reservoir and river sites in the Hydroelectric Reach (i.e., Klamath River upstream of J.C. Boyle Reservoir to Iron Gate Dam), *Aphanizomenon flos-aquae* made up approximately 26 percent of the total phytoplankton biovolume measured in 106 samples collected during 14 sampling events in January and May through December 2009 (Raymond 2010). While members of the *Aphanizomenon* genus have been shown to produce cylindrospermopsin[103] and several neurotoxins in laboratory cultures, they have not been shown to produce microcystin. Thus, while *Aphanizomenon flos-aquae* is commonly found in the Klamath Basin, it is not likely to be the source of microcystin in the Klamath River (Eldridge et al. 2012). Nitrogen fixation by *Aphanizomenon flos-aquae* can provide a new nitrogen source within lakes and rivers when *Aphanizomenon flos-aquae* cells die and decay releasing fixed nitrogen and other nutrients contained in their cells. The additional nitrogen released can provide nutrients for *Microcystis aeruginosa,* potentially promoting *Microcystis aeruginosa* growth later in the season (discussed further below).

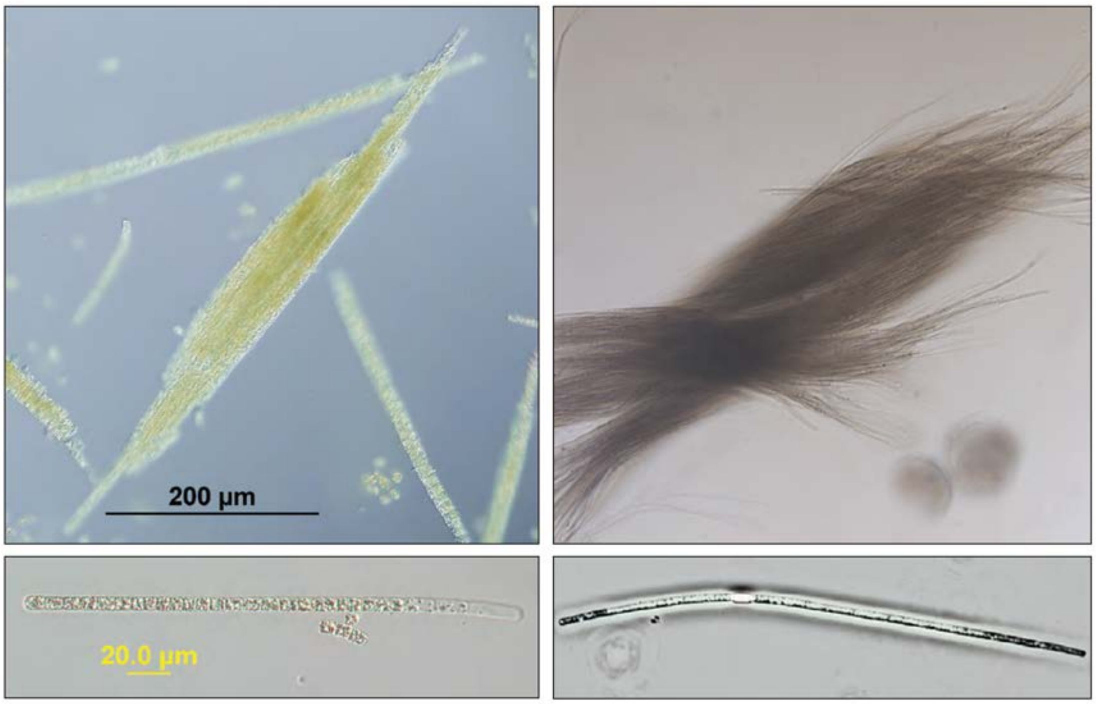

Figure 3.4-4. Microscopic View of *Aphanizomenon flos-aquae* Showing it in Bundles (upper left and right images) and Individual Filaments (lower left and right images). Photographs: Left, Barry H. Rosen; Right, Ann St. Amand. Source: Rosen and St. Amand 2015.

[103] An algal toxin associated with adverse health effects such as gastrointestinal, liver inflammation and hemorrhage, pneumonia, dermatitis, malaise, and long-term liver failure (Lopez et al. 2008). Cylindrospermopsin were only detected near or less than the method detection limit (<0.05 parts per billion) in the Upper Klamath Lake (Eldridge et al. 2012).

Figure 3.4-5. *Aphanizomenon flos-aquae* bloom. Photograph: Jacob Kann. Source: Rosen and St. Amand 2015.

***Anabaena flos-aquae*[104]**

Anabaena flos-aquae is also a filamentous (thread-like) nitrogen-fixing blue-green algae that occurs in the Klamath Basin (Figure 3.4-6; Kann 1997; Eldridge et al. 2012). Similar to *Aphanizomenon flos-aquae, Anabaena flos-aquae* can provide its own source of nitrogen for growth through nitrogen fixation and thus it has a competitive advantage over non-nitrogen fixing phytoplankton species under high phosphorous and low nitrogen conditions in streams or reservoirs. In phytoplankton sampling between June and November 2007, at 21 sites in the Klamath Basin from the Upper Klamath Lake to Turwar, including Copco No. 1 and Iron Gate reservoirs, *Anabaena flos-aquae* occurrence was low (i.e., less than 10 percent of samples). It was primarily found in Copco No. 1 and Iron Gate reservoirs, but it typically had low biovolumes on the order of 10,000 cubic micrometers per milliliter (um^3/mL) (Raymond 2008). In 2009, *Anabaena flos-aquae* comprised approximately 0.2 percent of the total phytoplankton biovolume measured in 106 samples collected during 14 sampling events at nine reservoir and river sites in the Hydroelectric Reach in January and May through December (Raymond 2010). Photographs of an algae bloom composed of primarily *Anabaena flos-aquae* are not available for the Klamath Basin, since it has not been found in isolation and has occurred at such low biovolumes.

Anabaena flos-aquae can produce several types of toxins, including anatoxin-a and microcystin (Lopez et al. 2008). Anatoxin-a is a neurotoxin which can cause irritation,

[104] *Anabaena flos-aquae* was recently renamed *Dolichospermum flos-aquae*. However, this EIR continues to use the *Anabaena* name since it was more frequently used in the literature cited and it is still commonly used in descriptions of this species.

muscle twitching, paralysis, and death. It was detected in September 2005 during one sampling event in Iron Gate Reservoir, at levels ranging from 22 to 34 µg/L (T. Mackie, pers. comm., 2005). Additional details about anatoxin-a concentrations measured in the Klamath River are found in Section 3.2.2.7 *Chlorophyll-a and Algal Toxins* and Appendix C – Section C.6 *Chlorophyll-a and Algal Toxins*. While anatoxin-a has been measured in the Klamath Basin, the extent of anatoxin-a production by *Anabaena flos-aquae* in the Area of Analysis for phytoplankton and periphyton is largely unknown due to the limited sampling to date. Toxin production by some strains of *Anabaena flos-aquae* appears to be sporadic, and the circumstances which prompt toxin production are unknown. While *Anabaena flos-aquae* have also been found to produce the algal toxin microcystin (Lopez et al. 2008), it is widely assumed that the severe blooms of *Microcystis aeruginosa* in the Area of Analysis are responsible for the detected concentrations of microcystin rather than *Anabaena flos-aquae* because the measured biovolume of *Anabaena flos-aquae* is typically much less than the *Microcystis aeruginosa* biovolume. The relative proportion of microcystin contributions from *Anabaena flos-aquae* versus *Microcystis aeruginosa* has not been documented for the Klamath Basin.

Figure 3.4-6. Microscopic view of *Anabaena flos-aquae,* recently renamed *Dolichospermum flos-aquae*. Source: Kudela Lab 2018.

Microcystis aeruginosa

Microcystis aeruginosa is a round- or oval-shaped unicellular, colony-forming cyanobacteria [blue-green algae] (Figure 3.4-7 and Figure 3.4-8; Eldridge et al. 2012). *Microcystis aeruginosa* are not capable of nitrogen fixation, unlike *Aphanizomenon flos-aquae* or *Anabaena flos-aquae*, so this species is dependent on ammonia and other nitrogen sources for growth, and the availability of nitrogen in the water column may limit their occurrence in portions of the Klamath Basin (Eldridge et al. 2012). In phytoplankton sampling conducted in Iron Gate and Copco No. 1 reservoir ranging from 2005 through 2010, *Microcystis aeruginosa* accounted for up to approximately 78 percent of the total phytoplankton biovolume in some samples collected at open water reservoir monitoring stations (Raymond 2008, 2009, 2010; Asarian et al. 2011), suggesting favorable habitat conditions in the reservoirs for this species.

Analysis of blue-green algae species present in the Klamath River from the Upper Klamath Lake to Turwar identified Iron Gate Reservoir as the principal source of *Microcystis aeruginosa* to the Klamath River downstream of Iron Gate Dam. Phytoplankton samples were collected either once or twice a month from April to December 2012 at fifteen sites along the Klamath River, including Copco No. 1 and Iron Gate reservoirs. The types of phytoplankton present were identified and genetic analysis (deoxyribonucleic acid [DNA] sequencing) was performed to identify genetic differences between the blue-green algae populations at the sample sites. Blue-green algae bloom populations at sites upstream of J.C. Boyle Dam were predominantly *Aphanizomenon flos-aquae* with some *Anabaena flos-aquae* (*Dolichospermum flos-aquae*) and a small amount of *Microcystis aeruginosa* present, but blue-green algae bloom populations in Copco No. 1 and Iron Gate reservoirs were primarily *Microcystis aeruginosa* and *Aphanizomenon flos-aquae*. *Microcystis aeruginosa* cells were present in low concentrations upstream of Copco No. 1 Reservoir, suggesting the majority of *Microcystis aeruginosa* cells in Copco No. 1 and Iron Gate reservoirs grew in the reservoirs and they were not transported into the reservoirs from upstream. Genetic analysis of the *Microcystis aeruginosa* populations showed Copco No. 1 Reservoir populations were dominated by one genetic type the entire year, but the *Microcystis aeruginosa* populations in Iron Gate Reservoir and immediately downstream of Iron Gate Dam had a simultaneous change in the dominant genetic type in late August. The genetic change was also detected in the *Microcystis aeruginosa* populations in the Klamath River downstream of Iron Gate Dam. The simultaneous timing of the genetic change in Iron Gate Reservoir and downstream *Microcystis aeruginosa* populations, but no corresponding genetic change in Copco No. 1 Reservoir, provides direct evidence that downstream river populations are originating in Iron Gate Reservoir rather than Copco No. 1 Reservoir or locations farther upstream (Otten et al. 2015).

Blooms of *Microcystis aeruginosa* are of particular concern since this species is known to produce the algal toxin microcystin, a hepatotoxin that affects liver function in animals and humans (State Water Board et al. 2010, updated 2016; OEHHA 2012). In humans, exposure to microcystin has been documented to cause abdominal pain, headache, sore throat, vomiting, nausea, dry cough, diarrhea, blistering around the mouth, pneumonia, muscle weakness, and acute liver failure (OEHHA 2012) (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*). Studies suggest that the presence of toxin producing *Microcystis aeruginosa* blooms could result in acute (short-term) and chronic (long-term) effects on fish including increased mortality, reduced fertility, reduced feeding, and habitat avoidance (Interagency Ecological Program 2007; Fetcho 2008, 2009; CH2M Hill 2009; Teh et al. 2010; Kann et al. 2013) (see also Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Project*).

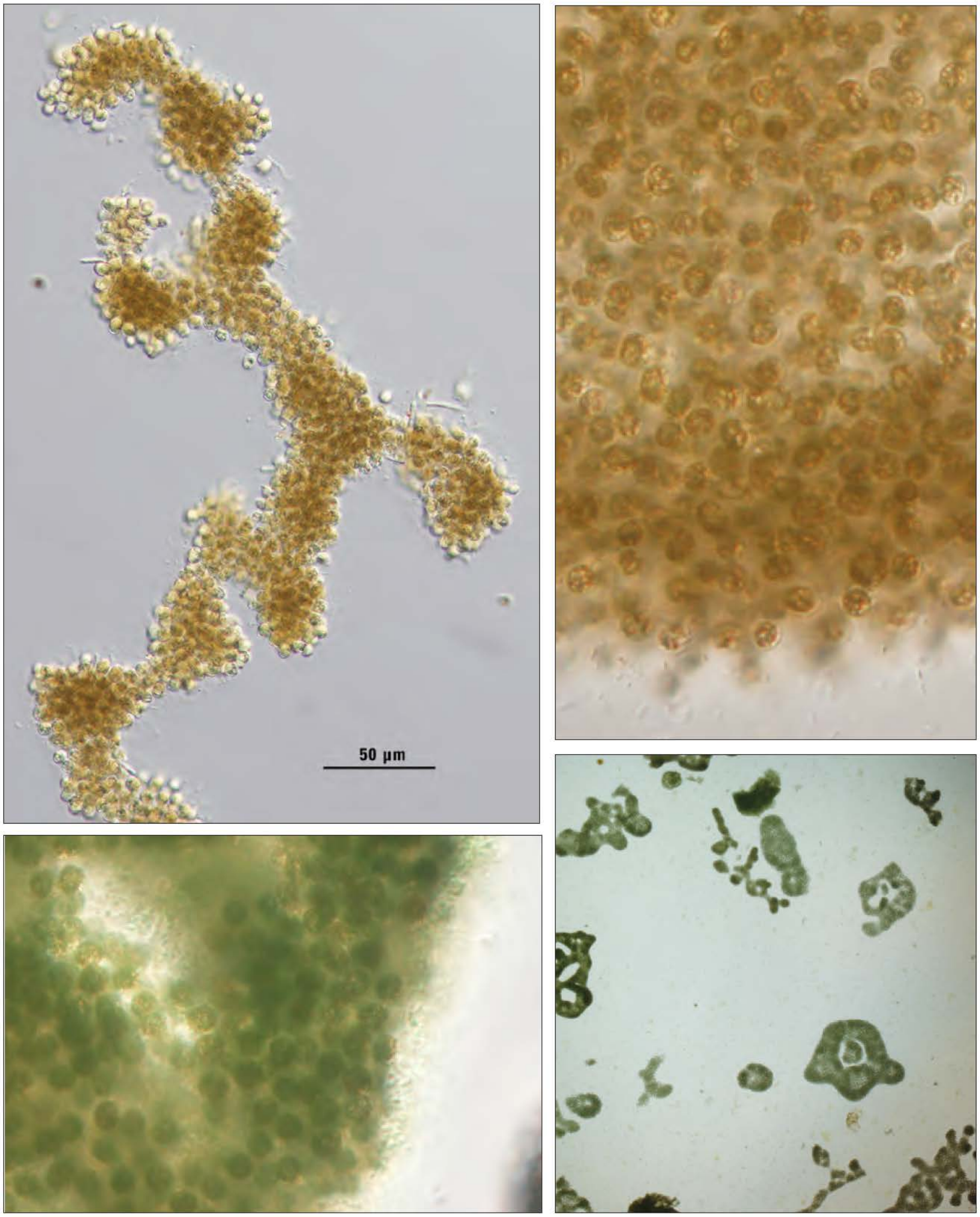

Figure 3.4-7. Microscopic views of *Microcystis aeruginosa*. Photographs: Barry H. Rosen. Source: Rosen and St. Amand 2015.

Figure 3.4-8. Blue-green algae *Microcystis aeruginosa* bloom. Photograph: Susan Corum. Source: Stillwater Sciences et al. 2013.

Algal blooms of nitrogen-fixing *Aphanizomenon flos-aquae* and *Anabaena flos-aquae* early in the year (spring) can supply a new nitrogen source to lakes or reservoirs, potentially promoting *Microcystis aeruginosa* growth later in the year (summer and fall) (FERC 2007; Eldrige et al. 2012; Otten et al. 2015). As blooms of *Aphanizomenon flos-aquae* and *Anabaena flos-aquae* die and decay, fixed nitrogen in their cells is released and becomes a source of nitrogen for *Microcystis aeruginosa*, which cannot fix nitrogen from the atmosphere. Studies of cyanobacteria [blue-green algae] dynamics in 2009 in the Upper Klamath Lake report a low initial *Microcystis aeruginosa* population followed by an increase after a major decline in an *Aphanizomenon flos-aquae* bloom. The *Microcystis aeruginosa* population continued to increase rapidly during a second *Aphanizomenon flos-aquae* bloom, suggesting that these two species can coexist (Eldridge et al. 2012).

Cyanobacteria [Blue-green Algae] Thresholds and Guidelines

Thresholds and guidelines for cyanobacteria [blue-green algae] densities (in cells/mL) and algal toxin concentrations (in µg/L) that are protective of human health have been established and are occasionally updated (see also Section 3.2.3.1 *Thresholds of Significance*). The World Health Organization (WHO) specifies for safe recreational water contact (not drinking water) a cell density of less than 20,000 cells/mL for cyanobacteria [blue-green algae] species and a microcystin concentration of less than 4 µg/L for a relatively low probability of adverse human health effects during recreational water contact (Falconer et al. 1999). The California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network, composed of various entities with expertise, including the State Water Board, the California Department of Public Health (CDPH), the California Environmental Protection Agency Office of Environmental Health and Hazard Assessment (OEHHA), Native American tribes, and reservoir managers has established thresholds and guidance for the cyanobacteria [blue-green algae] cell densities and cyanotoxin [algal toxin] concentrations for the protection of human health in recreational waters. The 2010 CCHAB thresholds (also referred to as the SWRCB/OEHHA Public Health Thresholds or the California Health Thresholds) recommended posting a health advisory warning sign[105] if the *Microcystis aeruginosa* cell density was greater than or equal to 40,000 cells/mL, the potentially toxigenic[106] cyanobacteria [blue-green algae] species cell density was greater than or equal to 100,000 cells/mL, or the microcystin concentration was greater than or equal to 8 ug/L. The 2016 CCHAB thresholds revised the 2010 CCHAB thresholds and specified primary and secondary threshold triggers for posting health advisories for recreational water contact (Table 3.4-1). The 2016 CCHAB thresholds are 4,000 cells/mL for total potentially toxigenic cyanobacteria [blue-green algae] species cell density and 0.8 ug/L for microcystin concentration, which are approximately one to two orders of magnitude less than the 2010 CCHAB thresholds (State Water Board et al. 2010, updated 2016).

Table 3.4-1. 2016 California Cyanobacteria Harmful Algal Bloom (CCHAB) Trigger Levels for Human Health.

Trigger Level	Primary Triggers[1]			Secondary Triggers	
	Total Microcystins (ug/L)	Anatoxin-a (ug/L)	Cylindrospermopsin (ug/L)	Total Potentially Toxigenic Cyanobacteria [Blue-green Algae] Species (cells/mL)	Site Specific Indicators of Cyanobacteria [Blue-green Algae]
Caution Action	0.8	Detection[2]	1	4,000	Blooms, scums, mats, etc.
Warning TIER I	6	20	4	-	-
Danger TIER II	20	90	17	-	-

Source: (State Water Board et al. 2010, updated 2016)
[1] Primary triggers are met when ANY toxin exceeds criteria.
[2] Must use an analytical method that detects less than or equal to 1 ug/L anatoxin-a.

[105] The advisory signs communicate to the public the potential risk of exposure to algal toxins in the associated waterbody and contain information about how to avoid or minimize the risk. The advisory signs include: "Caution – Harmful algae may be present in this water"; "Warning – Toxins from algae in this water can harm people and kill animals"; "Danger – Toxins from algae in this water can harm people and kill animals" (California Water Quality Monitoring Council 2018).
[106] Potentially toxigenic cyanobacteria [blue-green algae] that have been detected in California include those of the genera *Anabaena*, *Microcystis*, *Aphanizomenon*, *Planktothrix*, and *Gloeotrichia*.

The Hoopa Valley Tribe surface-water objectives are less than 100,000 cells/mL for total potentially toxigenic cyanobacteria [blue-green algae] species for recreational waters, less than 5,000 cells/mL *Microcystis aeruginosa* for drinking water, less than 40,000 cells/mL *Microcystis aeruginosa* for recreational water, and no cyanobacterial [blue-green algae] scums (see also Table 3.2-6). The Hoopa Valley Tribe surface-water objectives for algal toxins specify total microcystins less than 1 ug/L for drinking water and total microcystins less than 8 ug/L for recreational water (HVTEPA 2008). Similarly, the Yurok Tribe guidelines include posting "caution" public health advisories[105] when toxigenic blue-green algae species, *Microcystis aeruginosa*, or microcystin is detected; "warning" public health advisories when toxigenic blue-green algae species are greater than or equal to 100,000 cells/mL, *Microcystis aeruginosa* is greater than or equal to 1,000 cells/mL, or microcystin is greater than or equal to 0.8 ug/L; and "danger" public health advisories when toxigenic blue-green algae species are greater than or equal to 500,000 cells/mL, *Microcystis aeruginosa* is greater than or equal to 5,000 cells/mL, or microcystin is greater than or equal to 4.0 ug/L (see also Table 3.2-10; YTEP 2016).

Frequent exceedances of the cyanobacteria [blue-green algae] density and/or algal toxin concentration thresholds and guidelines have occurred since 2004 in the Lower Klamath Project reservoirs (Kann 2006) and since 2007 in the Middle and Lower Klamath River and the Klamath River Estuary (Chorus and Bartram 1999; Fetcho 2006, 2007, 2008; Kann 2008; Kann and Corum 2009; YTEP 2014, 2015; Genzoli and Kann 2016, 2017; Gibson 2016). The Klamath River from the upstream end of Copco No. 1 Reservoir to the Klamath River's confluence with the Trinity River is included in the CWA Section 303(d) list as impaired for microcystin due to regular exceedances of the established microcystin thresholds and water quality objectives (see also Table 3.2-3, Section 3.2.2.7 *Chlorophyll-a and Algal Toxins,* Potential Impact 3.2-12*,* Appendix C – Section C.6 *Chlorophyll-a and Algal Toxins*). Detailed discussion of phytoplankton communities by reach is presented below in Section 3.4.2.3 *Hydroelectric Reach* through Section 3.4.2.6 *Pacific Ocean nearshore environment*.

3.4.2.2 Periphyton

Periphyton are generally dominated by diatoms and green algae. Cyanobacteria [blue-green algae] can also occur in the periphyton community, but they are typically a small component of the community and do not reach nuisance levels (Asarian et al. 2014, 2015). Like phytoplankton in lakes and reservoirs, periphyton are important components of the base of the food web in riverine systems. Periphyton can also play an important role in riverine water quality, affecting nutrient cycling and resulting in diel (24-hour cycle) fluctuations in dissolved oxygen and pH (Anderson and Carpenter 1998, Kuwabara 1992, Tanner and Anderson 1996). Excessive swings in dissolved oxygen and pH can be stressful to aquatic biota, such that too much periphyton can adversely affect designated beneficial uses related to fish and other aquatic organisms (State Water Board 2001; HVTEPA 2008; North Coast Regional Board 2011). Monitoring at multiple locations along the Middle and Lower Klamath River indicates that dissolved oxygen and pH patterns over a 24-hour period are driven primarily by photosynthesis and respiration of periphyton (Ward and Armstrong 2010, Asarian et al. 2015). The repeatable and consistent diel cycling of dissolved oxygen is characteristic of a stream metabolism that is dominated by periphyton photosynthesis and respiration (Odum 1956). However, free-floating algae transported through the system likely exert some influence on the dissolved oxygen signal in the Klamath River, as does the oxygen demand from decaying organic matter (e.g., bacteria, algae, plant litter) exported from upstream Klamath River reservoirs (PacifiCorp 2006; FERC 2007).

Documented algae species in the Klamath River periphyton community include nuisance filamentous (thread-like) green algae species such as *Cladophora* sp. (FERC 2007), which can form dense mats in some places in the Lower Klamath River. These mats tend to be patchy and occur in lower velocity areas. They are not a dominant feature of the Klamath River, but in some locations they are an important habitat for the polychaete worm (*Manayunkia speciose*) that is the intermediate host of the fish parasites *Ceratomyxa shasta* and *Parvicapsula minibicornis* (Figure 3.4-9). The factors influencing periphyton abundance and community composition are complex and include physical factors such as nutrients, substrate, flow velocity, shading, light availability, and water temperature (Biggs 2000), as well as ecological factors (such as macroinvertebrate grazing) that interact with the physical factors (Power et al. 2008). The Lower Klamath Project dams influence the abundance of periphyton by altering the nutrient availability, riverbed substrate, flow, light availability, and water temperature in the Klamath River (NMFS 2010; NMFS and USFWS 2013; Alexander et al. 2016; Gillett et al. 2016). Analysis and modeling of pre- and post-Klamath Irrigation Project hydrology indicates that operation of the Klamath Irrigation Project upstream of the Lower Klamath Project dams has altered Klamath River flows by increasing flows in October and November, decreasing flows in the late-spring and summer, and decreasing the peak flows (NMFS and USFWS 2013). As a result of upstream Klamath Irrigation Project operations, the Klamath River peak flows downstream of Iron Gate Dam are less frequent, resulting in less frequent high-velocity flows that would scour streambed sediments downstream of the dam. In addition to lower peak flows, the Lower Klamath Project dams trap sediment behind the dams and reduce the availability of fine sediments downstream that can be transported at lower flows, leading to streambed armoring and less frequent scouring events that disturb the streambed. Reduced scouring frequency along with higher fall water temperatures, promote dense growth of periphyton. Additionally, operation of the upstream Klamath Irrigation Project results in flow modifications downstream of the Lower Klamath Project dams that alters the light availability for periphyton on the streambed, with lower flows generally decreasing water depth and increasing light penetration to the streambed for periphyton photosynthesis. These conditions favor proliferation of polychaete worm habitat and subsequent infection of fish by parasites (NMFS 2010; NMFS and USFWS 2013; Alexander et al. 2016) (see also Figure 3.4-8 [parasite life cycle]). Overall, data regarding the distribution, community composition, and biomass of periphyton in the Area of Analysis for phytoplankton and periphyton are limited.

Figure 3.4-9. Lifecycle of *Ceratomyxa shasta*. Source: NMFS 2012.

3.4.2.3 Hydroelectric Reach

Phytoplankton

Phytoplankton dynamics in the Hydroelectric Reach can be influenced by upstream conditions, so the following briefly discusses phytoplankton conditions from the Upper Klamath Lake to the Hydroelectric Reach before detailing the conditions within the Hydroelectric Reach. In the Upper Klamath Lake, the mean total phytoplankton biomass annually increases from relatively low concentrations ranging from less than 5 mg/L wet weight to approximately 15 mg/L wet weight per data collected between 1990 and 1996 in winter and spring (January to May) to peak concentrations ranging from approximately 30 mg/L wet weight to 60 mg/L wet weight per data collected between 1990 and 1996 in summer to fall (June to October), before decreasing to relatively low concentrations again in late fall/early winter (November to December) (Kann 1997). In addition to the seasonal change in total phytoplankton biomass, the phytoplankton community also has an annual seasonal shift from diatom-dominated communities in spring (Kann 1997; ODEQ 2002; Sullivan et al. 2009) to blue-green algae-dominated communities in summer and fall (Eilers et al. 2004; FERC 2007; Eldridge et al 2012). Phytoplankton biovolume in summer and fall is dominated by blue-green algae blooms comprised primarily of *Aphanizomenon flos-aquae*, but also includes *Anabaena flos-aquae* and *Microcystis aeruginosa* (Eilers et al. 2004; FERC 2007; Eldridge et al. 2012). Data from 2009 indicate concentrations of *Microcystis aeruginosa* in the Upper Klamath Lake are typically low during the early part of the calendar year, but concentrations increase later in the year following the decline of large blue-green algae blooms dominated by *Aphanizomenon flos-aquae* (Eldridge et al. 2012). *Microcystis aeruginosa* is believed to be responsible for the production of microcystin in the Upper Klamath Lake, which has exceeded the WHO guidelines for drinking water (1 ug/L) and safe recreational water contact (4 ug/L) with annual peaks in 2007 to 2009 between 1.6 and 24.4 ug/L (VanderKooi et al. 2010; Eldridge et al. 2012).

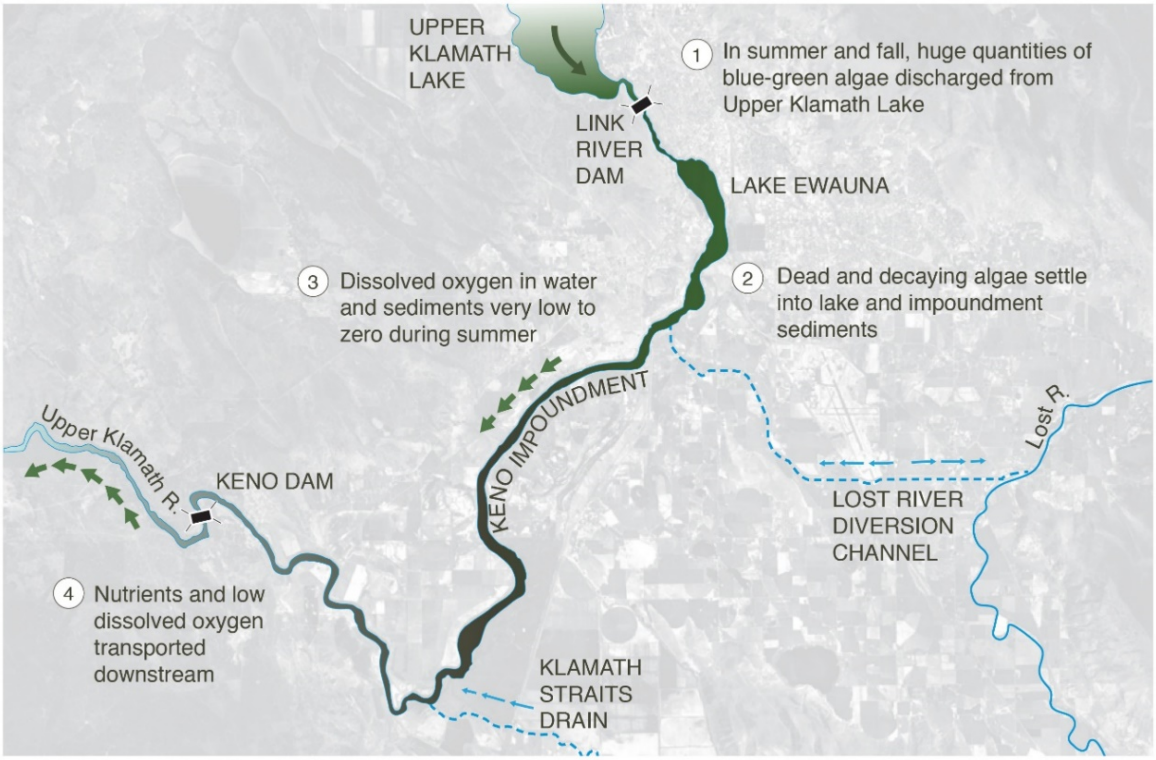

Figure 3.4-10. Blue-green algae transport from the Upper Klamath Lake into the Upper Klamath River. Blue-green algae do not completely die and settle out in the Keno Impoundment, with some blue-green algae exported into the Upper Klamath River downstream of Keno Dam. Source: Stillwater Sciences et al. 2013.

Phytoplankton patterns from the Link River downstream to Keno Dam are driven by blooms that originate in Upper Klamath Lake and are transported into this reach (Figure 3.4-10), with the phytoplankton community varying seasonally and reflecting the community present in the Upper Klamath Lake. In 2008, a total of 141 algae species were identified in the reach from Link River downstream to Keno Dam, with *Aphanizomenon flos-aquae* having the highest average density (61 percent) when present. In spring, 56 percent of the total phytoplankton biovolume was composed of diatoms, with blue-green algae making up only 24 percent the total phytoplankton biovolume. The remainder of the total phytoplankton biovolume was composed of other types of phytoplankton. In summer and fall, the phytoplankton community composition shifted to being primarily comprised of blue-green algae (76 to 80 percent of total phytoplankton biovolume), with diatoms (7 to 15 percent) and other phytoplankton (4 to 10 percent) making up the remainder of the total phytoplankton biovolume (Sullivan et al. 2009). Phytoplankton biovolume generally decreases in the Klamath River with distance downstream of Upper Klamath Lake, with the greatest median decrease in this reach occurring between the Upper Klamath Lake (at Pelican Marina/Fremont Street Bridge) and Link River (Figure 3.4-11; Raymond 2005; Kann and Asarian 2006; Sullivan et al. 2009). In Lake Ewauna and the Keno Impoundment, phytoplankton concentrations are observed to decrease, which is attributed to dead and decaying phytoplankton, especially blue-green algae, settling out of the water column and forming lake and impoundment sediments (Deas and Vaughn 2006; Stillwater Sciences et al. 2013; ODEQ 2017).

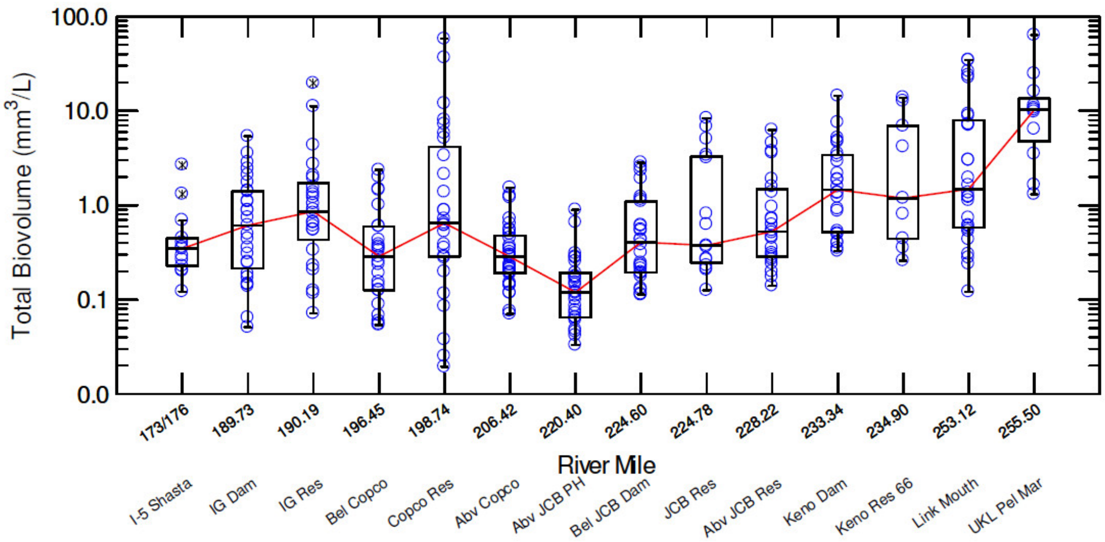

Figure 3.4-11. Total phytoplankton biovolume in mm^3/L from June 1 to September 30 for the years 2001 to 2004. River miles associated with Klamath River features are based on the river miles in 2006 and differ slightly from current river miles in this EIR. Station definitions: UKL Pel Mar = Upper Klamath River at Pelican Marina; Link Mouth = Link River at Mouth; Keno Res 66 = Klamath River at Hwy 66 Keno Bridge; Keno Dam = Keno Dam outflow; Abv JCB Res = Klamath River upstream of J.C. Boyle Reservoir; JCB Res = J.C. Boyle Reservoir at log boom; Bel JCB Dam = Klamath River downstream of J.C. Boyle Dam; Abv JCB PH = Klamath River upstream of the J.C. Boyle Powerhouse; Abv Copco = Klamath River upstream of Shovel Creek; Copco Res = Copco No. 1 Reservoir; Bel Copco = Klamath River downstream of Copco No. 2 Powerhouse; IG Res = Iron Gate Reservoir near dam; IG Dam = Klamath River downstream of Iron Gate Dam; I-5 Shasta = Klamath River at I-5 Rest Area and Klamath River upstream of Shasta River. Source: modified from Kann and Asarian 2006.

Phytoplankton abundance, including abundance of blue-green algae, generally decreases in the Klamath River with distance downstream of Keno Dam to upstream of Copco No. 1 Reservoir (Figure 3.4-11; Kann and Asarian 2006; Kann and Corum 2009; Asarian and Kann 2011; Watercourse Engineering, Inc. 2016). In this reach, turbulent mixing and higher water velocities that constitute unfavorable growing conditions and break apart phytoplankton cells, and cold groundwater-fed springs in the J.C. Boyle Bypass Reach that add flow and cool the river creating less favorable water temperatures for growth, result in decreasing phytoplankton concentrations and associated algal toxins (i.e., microcystin) between Keno Dam and the upstream end of Copco No. 1 Reservoir (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins* and Appendix C – Section C.6.1 *Upper Klamath Basin*). Additionally, the proportion of the phytoplankton community composed of diatoms increases relative to blue-green algae between Keno Dam and the upstream end of Copco No. 1 Reservoir (Kann and Asarian 2006).

Measurements of *Microcystis aeruginosa* abundance (measured by biovolume) between 2001 and 2004 also show a decreasing trend from Upper Klamath Lake to upstream of Copco No. 1 Reservoir (Figure 3.4-12). Individual measurements for *Microcystis aeruginosa* taken during this period are represented by circles (o) in Figure 3.4-12, but the circles overlap and appear as a single circle when multiple measurements have the same value (e.g., multiple non-detect results for sites appear as a single circle at zero along the x-axis). Box and whisker features showing the statistical trends (e.g., 25 to 75 percent of measurements occur within the biovolume range encompassed by the box) are shown for most sites, but these box and whisker features cannot be seen for sites with primarily non-detect results for *Microcystis aeruginosa* (i.e., biovolume equal to zero) because they are compressed at the x-axis. While there were eight detections (44 percent of measurements) of *Microcystis aeruginosa* in the Keno Impoundment/Lake Ewauna, no *Microcystis aeruginosa* was detected in 24 samples collected between the Keno Dam outflow and the Klamath River site upstream of J.C. Boyle Reservoir. At sites from J.C. Boyle Reservoir to the Klamath River site upstream of Copco No. 1 Reservoir, there were one to two detections (5 to 15 percent of measurements) per site in the July to October period (Kann 2006).

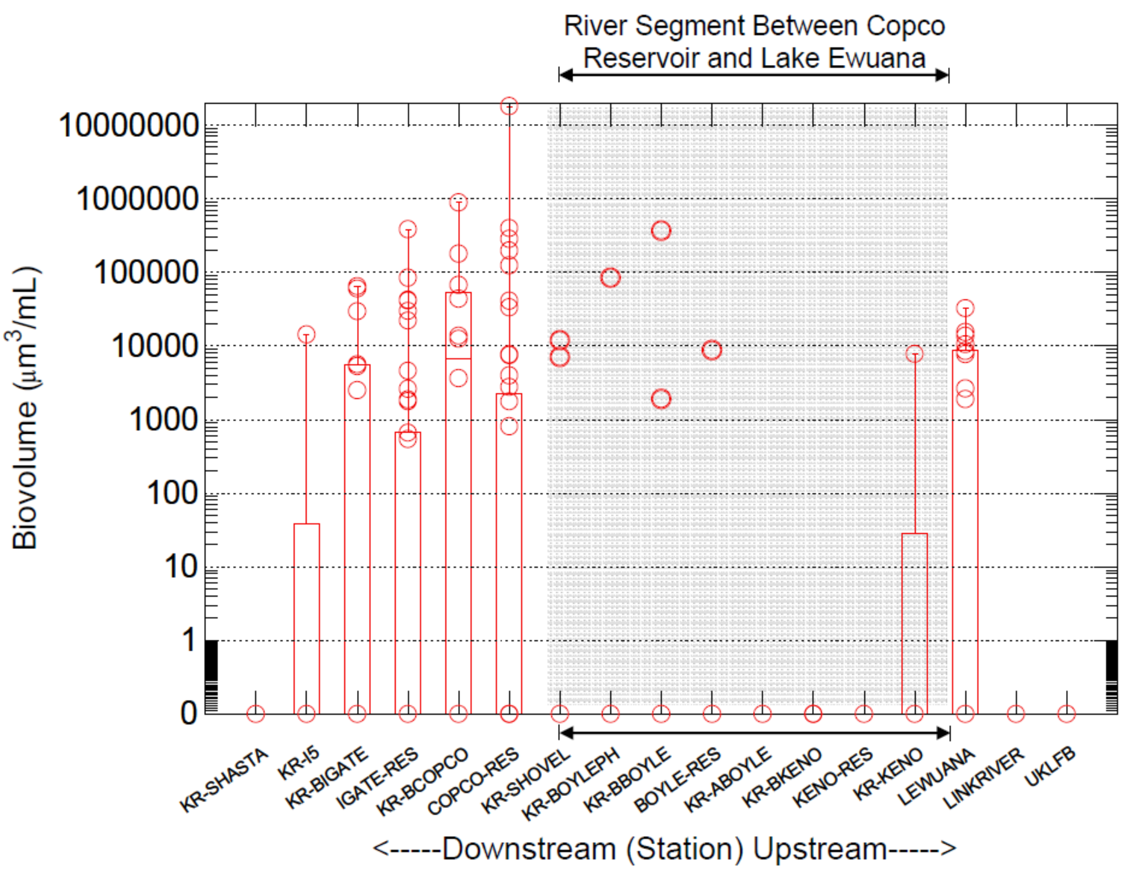

Figure 3.4-12. *Microcystis aeruginosa* biovolume in um^3/mL from July to October for the years 2001 to 2004. No *Microcystis aeruginosa* were detected before July or after October. Station definitions: UKLFB = Upper Klamath Lake at Fremont St. Bridge; LINKRIVER = Link River at mouth; LEWUANA = Lake Ewauna; KR-KENO = Klamath River upstream of Keno Reservoir; KENO-RES = Keno Reservoir; KR-BKENO = Klamath River downstream of Keno Reservoir; KR-ABOYLE = Klamath River upstream of J.C. Boyle Reservoir; BOYLE-RES = J.C. Boyle Reservoir; KR-BBOYLE = Klamath River downstream of J.C. Boyle; KR-BOYLEPH = Klamath River upstream of J.C. Boyle Powerhouse; KR-SHOVEL = Klamath River upstream of Shovel Creek; COPCO-RES = Copco No. 1 Reservoir; KR-BCOPCO = Klamath River downstream of Copco No. 2 Powerhouse; IGATE-RES = Iron Gate Reservoir; KR-BIGATE = Klamath River downstream of Iron Gate Dam; KR-I5 = Klamath River at I-5 Rest Area; KR-SHASTA = Klamath River upstream of Shasta River. Individual measurements are represented by circles (o), with overlapping circles appearing as a single circle when multiple measurements have the same value. Box and whisker features cannot be seen for sites with primarily non-detect results for *Microcystis aeruginosa* (i.e., biovolume equal to zero) because they are compressed at the x-axis. Source: Kann 2006.

The decreasing riverine trend with respect to algal cell concentration in the Hydroelectric Reach is interrupted by large summer and fall blooms of cyanobacteria [blue-green algae] in Copco No. 1 and Iron Gate reservoirs (Kann and Asarian 2006; Raymond 2008, 2009, 2010; Asarian et al. 2009; Asarian and Kann 2011; Otten et al. 2015; Watercourse Engineering, Inc. 2016; Otten and Dreher 2017). In these two reservoirs, a bloom of diatoms generally occurs in spring to early summer, followed by a period of low chlorophyll-*a* concentrations (FERC 2007; Raymond 2008, 2009, 2010; Asarian and Kann 2011) (see also Appendix C – Section C.6.1.1 *Hydroelectric Reach*). Large phytoplankton blooms occur in the reservoirs in mid-summer, dominated by *Aphanizomenon flos-aquae,* which are then followed by a late-summer or early-fall bloom of toxigenic *Microcystis aeruginosa* (Kann 2006; FERC 2007; Raymond 2008, 2009, 2010; Asarian and Kann 2011; Eldridge et al. 2012; Otten et al. 2015; Otten and Dreher 2017). During the late-season *Microcystis aeruginosa* bloom, this species typically constitutes a higher proportion of the overall algal biomass in Copco No. 1 and Iron Gate reservoirs than it does in blooms occurring in Upper Klamath Lake (Kann and Asarian 2006; Raymond 2008, 2009, 2010; Asarian and Kann 2011; Eldrige et al. 2012; Otten et al. 2015). Recent data from August and September 2012 using genetic analysis of the cyanobacteria [blue-green algae] community dynamics further confirms these trends in the Klamath River and its reservoirs. In Upper Klamath Lake in both August and September 2012, *Aphanizomenon flos-aquae* made up more than 75 percent of the blue-green algae population, while *Microcystis aeruginosa* was less than 1 percent. During that same time period, the cyanobacteria [blue-green algae] community composition shifted in Copco No. 1 and Iron Gate reservoirs from greater than approximately 90 percent *Aphanizomenon flos-aquae* and less than approximately 5 percent *Microcystis aeruginosa* (August 2012) to approximately 10 to 45 percent *Aphanizomenon flos-aquae* and approximately 50 to 90 percent *Microcystis aeruginosa* (September 2012). The remaining cyanobacteria [blue-green algae] community in Upper Klamath Lake, Copco No. 1 Reservoir, and Iron Gate Reservoir during this time was primarily comprised of *Anabaena flos-aquae* (*Dolichospermum flos-aquae*) (Otten et al. 2015).

Copco No. 1 and Iron Gate reservoirs provide ideal habitat conditions for the proliferation of large seasonal blooms of *Microcystis aeruginosa*, which subsequently become the source of *Microcystis aeruginosa* to the Middle and Lower Klamath River. This pattern is robust and repeatable in most years. Figure 3.4-2, modified from Kann and Asarian (2007), illustrates the pattern in 2005. At the Klamath River station, just upstream of Copco No. 1 Reservoir ("KRAC" in Figure 3.4-2), *Microcystis aeruginosa* was never detected during multiple summer samplings; however, nitrogen-fixing blue-green algae such as *Aphanizomenon flos-aquae* were detected at KRAC during that period (Kann and Asarian 2007). During the same period, blooms of *Microcystis aeruginosa* within the reservoirs (Copco No. 1 Reservoir stations CR02 and CR01 and Iron Gate Reservoir stations IR03 and IR01) were pronounced. Among all reservoir samplings in 2005, *Microcystis aeruginosa* comprised 20 to 60 percent of sample biovolume and during some periods it was 60 to 100 percent of sample biovolume, particularly in Iron Gate Reservoir. Significant export of the *Microcystis aeruginosa* bloom from Iron Gate Reservoir to downstream reaches of the Klamath River is evident by the relatively high biovolume observed at the river station downstream from Iron Gate Dam (KRBI). Nearly identical patterns were documented for other years, such as 2006 (Kann and Corum 2007), 2008 (Kann and Corum 2009), 2012 (Otten et al. 2015), and 2015 (Watercourse Engineering, Inc. 2016), as well as patterns aggregated over longer time periods such as 2001 to 2004 (Kann 2006), 2005 to 2011 (Asarian and Kann 2011) demonstrating the repeatable nature of this phenomenon.

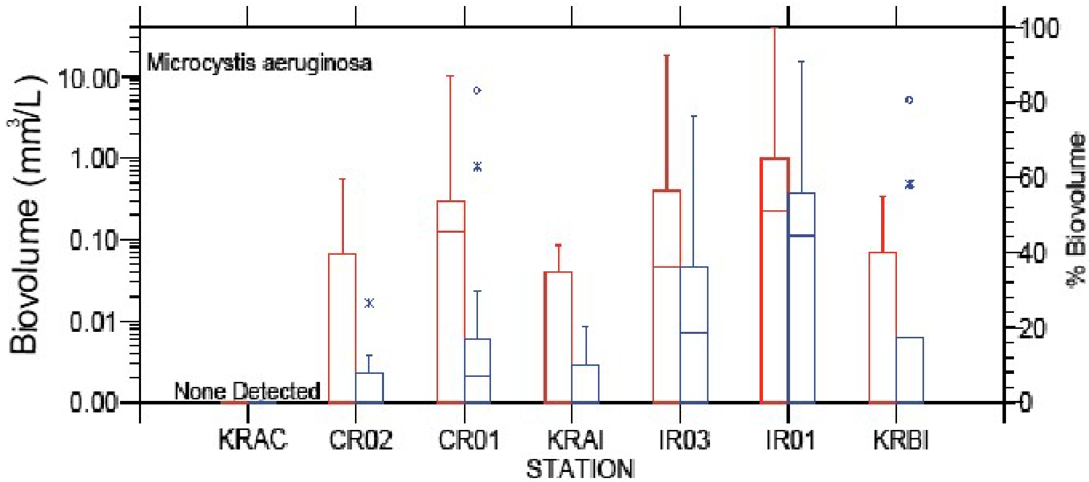

Figure 3.4-13. Biovolume (in red) and percent biovolume (in blue) of *Microcystis aeruginosa* above, within, and downstream from Copco No. 1 and Iron Gate reservoirs during 2005. Station definitions: KRAC = Klamath River upstream of Copco No. 1 Reservoir; CR01 = Copco No. 1 Reservoir Station 1; CR02 = Copco No. 1 Reservoir Station 2; KRAI = Klamath River upstream of Iron Gate Reservoir; IR03 = Iron Gate Reservoir Station 3; IR01 = Iron Gate Reservoir Station 1; KRBI = Klamath River downstream of Iron Gate Reservoir. Source: modified from Kann and Asarian (2007).

As previously noted in Section 3.4.2.1 *Phytoplankton*, genetic analysis of the *Microcystis aeruginosa* in Copco No. 1 Reservoir, Iron Gate Reservoir, and multiple Klamath River sites downstream of Iron Gate Dam also identified Iron Gate Reservoir as the principal source of *Microcystis aeruginosa* to the Klamath River downstream of Iron Gate Dam (Otten et al. 2015). In 2012, measured *Microcystis aeruginosa* at sites in the Klamath River and its reservoirs was comprised of two distinct genetic types (SNP 131-A and SNP 131-G) of *Microcystis aeruginosa.* These two genetic types were either not detected (Upper Klamath Lake) or infrequently detected upstream of Copco No. 1 Reservoir. In Copco No. 1 Reservoir, SNP 131-A was the dominant type (i.e., highest relative proportion) of *Microcystis aeruginosa* throughout the measurement period from June to December 2012. The dominant genetic type varied in Iron Gate Reservoir and downstream Klamath River sites, with a shift from SNP 131-A to SNP 131-G in July and August, followed by another change from SNP 131-G back to SNP 131-A in September (Figure 3.4-14). Both shifts in the dominant genetic type at Iron Gate Reservoir and downstream Klamath River sites occurred simultaneously without a corresponding genetic shift in Copco No. 1 Reservoir. This provides direct evidence that in 2012 downstream populations originated in Iron Gate Reservoir rather than Copco No. 1 Reservoir or further upstream (Otten et al. 2015).

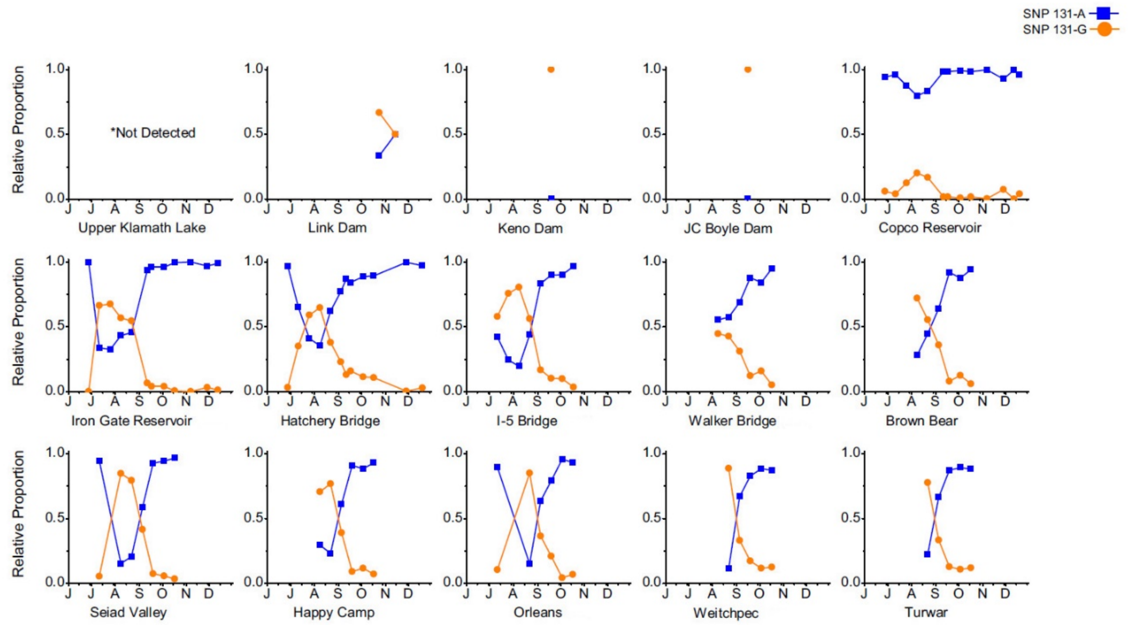

Figure 3.4-14. Relative proportion of the *Microcystis aeruginosa* population comprised of two *Microcystis aeruginosa* genetic types (SNP 131-A and SNP 131-G) at sites in the Klamath River and reservoirs. Relative proportion ranges from 1.0 (100 percent) to 0.0 (0 percent). The month is specified using the first letter of the month starting from June. Source: modified from Otten et al. 2015.

As illustrated Figure 3.4-12 and Figure 3.4-14, the main supply of *Microcystis aeruginosa* was not from sources upstream of Copco No. 1 Reservoir (i.e., Upper Klamath Lake), but instead most likely originated within Iron Gate Reservoir and continued downstream. Although some colonies of *Aphanizomenon flos-aquae* and *Microcystis aeruginosa* are transported into the Hydroelectric Reach from upstream sources, the low detection of *Aphanizomenon flos-aquae* and *Microcystis aeruginosa* at the monitoring sites upstream of Copco No. 1 Reservoir indicate that *Aphanizomenon flos-aquae* and *Microcystis aeruginosa* are primarily generated within Copco No. 1 and Iron Gate reservoirs (Asarian and Kann 2011; Otten et al. 2015). Additionally, the genetic and toxin analyses show that the *Microcystis aeruginosa* populations in Copco No. 1 and Iron Gate reservoirs are genetically distinct, providing evidence that blooms in Iron Gate Reservoir are internally derived and not due to transport of *Microcystis aeruginosa* populations from Copco No. 1 Reservoir or further upstream (Otten et al. 2015).

The documented presence of algal toxins in water and fish tissue in the Hydroelectric Reach corresponds with spatial and temporal patterns in the distribution of blue-green algae blooms within the reach. Recent data indicate that microcystin is undetectable or at very low levels in the Upper Klamath River at the upstream entrance to the Hydroelectric Reach, but microcystin increases through the reach as water is impounded in Copco No. 1 and Iron Gate reservoirs. The reservoirs create ideal growing conditions for toxigenic blue-green algae (calm, stable lacustrine conditions with bioavailable nutrients), regularly resulting in high microcystin concentrations from approximately July through October (Kann and Corum 2006, 2009; Asarian and Kann 2011; Otten et al. 2015; Watercourse Engineering, Inc. 2016; Otten and Dreher 2017). The CCHAB Network, consisting of the State Water Board, CDPH, OEHHA, Native American tribes, and reservoir managers, has primary and secondary cyanotoxin [algal toxin] trigger threshold levels that would result in posting public health advisories[105] for a water body (e.g., lake, reservoir, or river reach), if one or more of the algal toxin threshold levels is exceeded. While microcystin is the algal toxin typically measured in water bodies, the algal toxins anatoxin-a and cylindrospermopsin also have threshold levels which would trigger posting of the water body (see also Section 3.4.2.1 *Phytoplankton*).

Since 2005, high levels of microcystin have prompted the posting of public health advisories around Copco No. 1 and Iron Gate reservoirs, and during certain years along reaches of the Middle and Lower Klamath River downstream from Iron Gate Dam in the late summer months (see Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*, Appendix C – Section C.6.1.1 *Hydroelectric Reach* for more detail). In 2010, the Lower Klamath Project reservoirs and the entire Klamath River downstream from Iron Gate Dam (including the Klamath River Estuary) were posted to protect public health due to elevated blue-green algae cell counts (i.e., *Aphanizomenon flos-aquae, Anabaena flos-aquae,* and *Microcystis aeruginosa*) and algal toxin (i.e., microcystin) concentrations. Public health advisories for both Copco No. 1 and Iron Gate reservoirs were also posted in 2012 (North Coast Regional Board 2012), 2013 (North Coast Regional Board 2013), 2014 (North Coast Regional Board 2014), 2015 (Watercourse Engineering, Inc. 2016), and 2016 (North Coast Regional Board 2016). Measurement of elevated algal toxin (i.e., microcystin) concentrations also prompted a public health advisory in 2017 for Copco No. 1 and Iron Gate reservoirs and reaches of the Klamath River downstream of Iron Gate Dam (North Coast Regional Board 2017). Blue-green algae cell counts and microcystin concentrations greater than CCHAB thresholds for posting public health advisories were also measured in Copco No. 1 and Iron Gate during summer and fall 2018 (E&S Environmental Chemistry, Inc. 2018b). High cell counts and toxin concentrations in the water column can result in bioaccumulation of microcystin in muscle and/or liver tissues of resident (e.g., yellow perch) and anadromous fish (e.g., juvenile hatchery Chinook, adult Chinook salmon, steelhead) and in freshwater mussels (Kann 2008; Kann and Corum 2009; PacifiCorp 2010; Kann et al. 2011; Kann et al. 2013) (see also Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Project*).

Periphyton

Nuisance blooms of periphyton have not been documented in the riverine portions of the Hydroelectric Reach. In the J.C. Boyle Peaking Reach, it has been noted that periphyton tends to be absent from the margins of the river that are alternately dried and wetted during peaking operations (E. Asarian, pers. comm., 2011).

3.4.2.4 Middle and Lower Klamath River

Phytoplankton

Although both *Aphanizomenon flos-aquae* and *Microcystis aeruginosa* have been observed in the Klamath River just downstream from Iron Gate Dam, and as far downstream as the Klamath River Estuary, this reach of the river is more suitable for the growth of periphyton and does not provide optimal habitat for phytoplankton species that typically thrive in reservoir and lake environments. As discussed above, data collected in 2001 through 2010 suggest that the phytoplankton composition of Klamath River sites immediately downstream from Iron Gate Reservoir is dominated by cyanobacteria [blue-green algae] on a seasonal basis, when large blooms occurring in this reservoir are transported downstream (Kann and Asarian 2006; Asarian and Kann 2011). Additional monitoring from 2013 to 2018 further documents the seasonal abundance of cyanobacteria [blue-green algae] downstream of Iron Gate Dam (E&S Environmental Chemistry, Inc. 2013, 2014, 2015, 2016, 2018a, 2018b). Genetic analysis of *Microcystis aeruginosa* indicates genetic similarities of populations found in Iron Gate Reservoir and downstream river sites, providing further evidence that Iron Gate Reservoir is the source of *Microcystis aeruginosa* populations in the Klamath River downstream of Iron Gate Dam (see Section 3.4.2.3 above; Otten et al. 2015).

In general, turbulent mixing, increased velocity, and tributary dilution result in a gradual decrease in suspended algal materials from the Klamath River water column as the river travels downstream (Armstrong and Ward 2008; Ward and Armstrong 2010) (see also discussion in Appendix C – Section C.2.2.1 *Iron Gate Dam to Salmon River* and Section C.6.2.1 *Iron Gate Dam to Salmon River*). *Microcystis aeruginosa* transported downstream from Copco No. 1 and Iron Gate reservoirs can become trapped and accumulate in calm pools and eddies along the edges of the Middle and Lower Klamath River (Kann and Corum 2006) in some years (e.g., 2007) resulting in pockets of highly concentrated cyanobacteria [blue-green algae] along the river shoreline in greater concentrations than those measured immediately downstream from Iron Gate Dam (Fetcho 2008; Raymond 2008; Kann and Corum 2009; Kann et al. 2010). The spatially and temporally variable nature of blue-green algae blooms along the edges of the Middle and Lower Klamath River makes it difficult to fully assess the distribution and frequency of these events (Kann and Corum 2009). In measurements of the cyanobacteria [blue-green algae] cell density across one transect of the Klamath River, the cyanobacteria [blue-green algae] cell density was substantially higher near the shoreline where turbulent mixing and water velocities were lower (Figure 3.4-15; Kann et al. 2010; Genzoli and Kann 2016, 2017). The presence of blue-green algae along the shoreline is particularly important because the shoreline is where animals (e.g., pets) and humans are most likely come in contact with water and any blue-green algae or algal toxins present in the water, especially during recreational activities (see Section 3.20.2.2 *Klamath River-based Recreation*). At times, accumulations of cyanobacteria [blue-green algae], including *Microcystis aeruginosa,* along shorelines and in protected coves and backwaters in the Middle and Lower Klamath River can result in exceedances to the 2016 CCHAB secondary thresholds for the protection of human health (4,000 cells/mL of all toxin-producing cyanobacteria [blue-green algae] or site specific indicators of cyanobacteria [blue-green algae] like blooms, scums, or mats) and the WHO guidelines for *Microcystis aeruginosa* cell density (20,000 cells/mL for a relatively low probability of adverse human health effects) (Falconer et al. 1999; State Water Board et al. 2010, updated 2016). These thresholds and guidelines have been set for safe recreational water contact (not drinking water) (see also Section 3.4.2.1 *Phytoplankton*)

Despite these localized accumulations of blue-green algae along shorelines and in backwaters, data collected in June through November during 2005 to 2015 indicate that the measured *Microcystis aeruginosa* cell density at river sites in the Middle and Lower Klamath River was usually less than the vast majority of measured *Microcystis aeruginosa* cell densities in Copco No. 1 and Iron Gate reservoir sites (Appendix C, Figure C-49; see also Kann et al. 2010; Kann and Bowman 2012; Genzoli and Kann 2017). While the majority of *Microcystis aeruginosa* cell density measurements at river sites in the Middle and Lower Klamath River were less than the 2010 CCHAB (SWRCB/OEHHA Public Health) threshold of 40,000 cells/mL, the measured *Microcystis aeruginosa* cell densities at river sites frequently exceeded the 2016 CCHAB threshold of 4,000 cells/mL (Genzoli and Kann 2017). The measured *Microcystis aeruginosa* cell density at river sites in the Middle and Lower Klamath River in June through November during 2005 to 2015 was typically less than the higher WHO guidelines (20,000 cells/mL), but measurements of *Microcystis aeruginosa* cell density from the Klamath River I-5 Rest Area (RM 181.8) to Orleans (RM 58.9) reached 20,024 to 35,784 cells/mL in late July/early August 2015, with the maximum occurring at Seiad Valley (RM 132.7) (Watercourse Engineering, Inc. 2016).

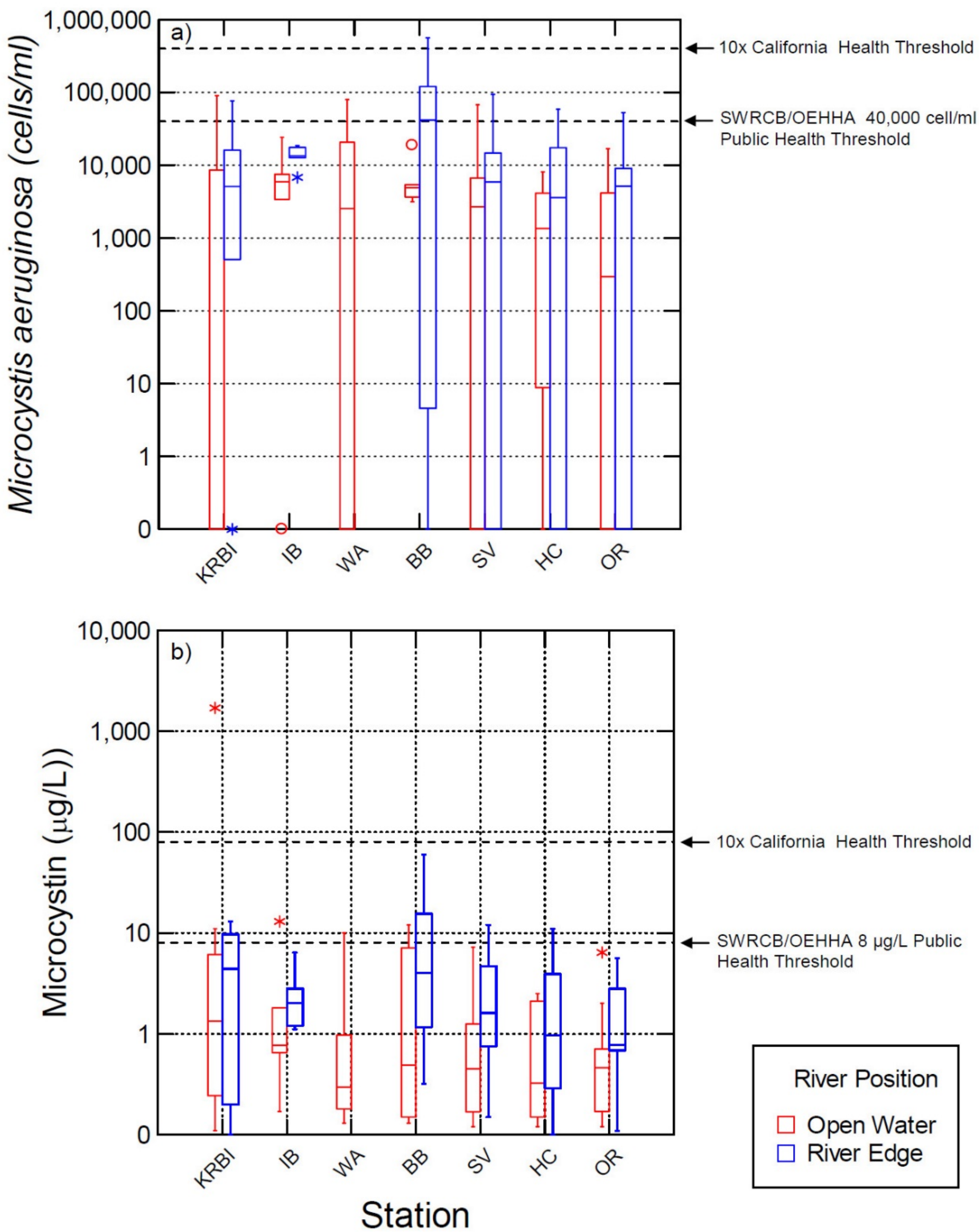

Figure 3.4-15. *Microcystis aeruginosa* density and microcystin concentration variations between open water and along the river edge in the Klamath River. Station locations on the Klamath River: KRBI = Klamath River downstream of Iron Gate Dam; IB = I-5 Bridge; WA = Walker Bridge; BB = Brown Bear River Access just east of Horse Creek; SV = Seiad Valley; HC = Happy Camp; and OR = Orleans. Thresholds listed are those that were applicable when study was published and do not reflect current thresholds. Current threshold is 0.8 ug/l as discussed in Section 3.4.2.1 *Phytoplankton*. Source: Kann et al. 2010.

Algal toxins (e.g., microcystin, anatoxin-a) are a critical concern in the Klamath River downstream from Iron Gate Dam, because they can remain viable along the low-velocity margins of the river where little mixing occurs (Kann and Corum 2009; Genzoli and Kann 2016, 2017). During cyanobacteria [blue-green algae] growth, most toxins are contained within the cells of the cyanobacteria [blue-green algae]. However, once cyanobacteria [blue-green algae] die and decay, its cells break apart (lyse) and toxins are released (Falconer et al. 1999). Microcystin is the primary algal toxin concern in the Klamath River downstream of Iron Gate Dam, because microcystin is extremely stable and resists common chemical breakdown such as hydrolysis, oxidation, or photolysis (i.e., photochemical degradation by sunlight) under conditions found in most natural water bodies. The time it takes for half of the microcystin to break down (i.e., half-life) under typical ambient conditions is 10 weeks (OEHHA 2009), so microcystin concentrations can continue to increase over multiple weeks in the areas of the Klamath River with limited mixing as blue-green algae continue to die, decay, and release microcystin. Even after boiling, microcystin can persist in water, indicating that cooking is not sufficient to destroy microcystin (Chorus and Bartram 1999; OEHHA 2009). Anatoxin-a, the other blue-green algae toxin that has been detected in the Klamath River downstream of Iron Gate Dam (see Appendix C – Section C.6.2 *Mid- and Lower Klamath Basin*), is much less stable than microcystin, with a half-life of 1 to 10 hours in natural light under typical ambient conditions. Anatoxin-a has been found to persist up to 21 days at low pH (4 s.u.) or up to several months in the absence of sunlight (USEPA 2015).

Concentrations of microcystin in the Klamath River downstream from Iron Gate Dam are typically 1 to 3 orders of magnitude lower than observed in Copco No. 1 and Iron Gate reservoirs (Appendix C, Figure C-49; see also Raymond 2008; Kann et al. 2010; Kann and Bowman 2012). However, the lowest 2016 CCHAB threshold (0.8 ug/L), the 2010 CCHAB (SWRCB/OEHHA Public Health) threshold (8 ug/L), the WHO guideline (4 ug/L), the Hoopa Valley Tribe recreational water objective (8 ug/L), and the lowest Yurok Tribe guideline (detection) for exposure to microcystin have each been exceeded downstream from Iron Gate Dam on numerous occasions (Kann 2004; Kann and Corum 2009; Kann et al. 2010; Fetcho 2011; Kann and Bowman 2012; Watercourse Engineering, Inc. 2012, 2013, 2014, 2015, 2016; KTWQC 2016), including late-summer/early-fall *Microcystis aeruginosa* blooms in September 2007, 2009, 2010, 2011, 2012, 2013, and 2016 from Iron Gate Dam (RM 193.1) to the mouth of the Klamath River (RM 0.5). Overall, the data indicate that while Middle and Lower Klamath River microcystin exceedances do occur, they are far less in number than exceedances in Copco No. 1 and Iron Gate reservoirs (Appendix C, Figure C-49; see also Raymond 2008; Kann et al. 2010; Kann and Bowman 2012). Data from 2007 also indicate that microcystin can bioaccumulate in juvenile salmonids reared in Iron Gate Hatchery (see Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project* for more details; Kann 2008), potentially resulting in earlier hatching; disruption of development, growth, immune status, and cardiac function; damage to the liver, kidney, and gills; and death (OEHHA 2009).

Overall, the literature and studies to date overwhelmingly support the conclusion that blue-green algae blooms in Iron Gate Reservoir are the primary source of *Microcystis aeruginosa* detected seasonally in the Klamath River downstream from the Hydroelectric Reach. Additionally, Copco No. 1 Reservoir may also contribute to *Microcystis aeruginosa* populations in these reaches. Measured data along with the persistence of microcystin in the environment indicate that microcystin concentrations downstream of J.C. Boyle are typically below detectable concentrations with only infrequent measurements, so blue-green algae blooms in both Copco No. 1 and Iron Gate reservoirs provide the primary source of the seasonally detected microcystin in the Klamath River downstream from the Hydroelectric Reach rather than transport of microcystin from upstream of Copco No. 1 through the reservoirs and into the Middle or Lower Klamath River. The relatively high turbulence and velocity of the Middle and Lower Klamath River makes it poor habitat for blue-green algae species to thrive in most reaches, although colonies of *Microcystis aeruginosa* can be transported into the river from Iron Gate Reservoir and potentially Copco No. 1 Reservoir and accumulate, and in some cases, may persist in the localized pools and edges of the river. That Copco No. 1 and Iron Gate reservoirs receive excessive nutrients and potentially a small amount of viable blue-green algae cells transported from upstream of the Hydroelectric Reach, while well documented, does not diminish the fundamental role of Copco No. 1 Reservoir and especially Iron Gate Reservoir, in fostering excessive growth of *Microcystis aeruginosa,* the production of high concentrations of microcystin, and the downstream transport of both, to the Middle and Lower Klamath River.

Periphyton

Periphyton sampling in the Klamath River downstream from Iron Gate Dam reveals distinct longitudinal and seasonal patterns in species composition. In a single survey undertaken downstream of Iron Gate Dam between September 1 and 2, 2004, Eilers (2005) documented relatively high periphyton coverage (near 80 percent) on stream rocks and periphyton chlorophyll-*a* content (near 50 micrograms per square centimeter [ug/cm^2]) immediately downstream from Iron Gate Dam ([RM 193.1]). Several miles downstream, near the Collier Rest Area at the I-5 bridge (RM 182.1), periphyton coverage (near 10 percent) on stream rocks was relatively low. Downstream from the Collier Rest Area, both periphyton coverage and chlorophyll-*a* content increased gradually to peak levels near the confluence with the Salmon River (RM 66). While periphyton biomass was generally found to be low to moderate during the survey (with the exception of the site immediately downstream from Iron Gate Dam), it is believed that increased discharge (i.e., a doubling of flow from approximately 600 cfs around August 15 to approximately 1,200 cfs near the end of August, and decreasing to approximately 800 cfs by September 1, the start of the survey) may have dislodged filamentous algae that had proliferated under the previous lower flow regime (Eilers 2005; FERC 2007).

Analysis of periphyton data collected between 2004 and 2013 indicates that attached diatoms represent the highest percentage of total periphyton biomass in the Middle and Lower Klamath River, but variations in the periphyton community occur in specific reaches and time periods (Asarian et al. 2014, 2015). During June through October, periphyton communities[107] occurring from Iron Gate Dam (RM 193.1) to RM 160 tend to exhibit the highest percentage of species tolerant of degraded dissolved oxygen conditions, bacteria capable of obtaining energy from organic nitrogen-containing compounds as well as from photosynthesis, and free-floating, un-attached algae species, including cyanobacteria [blue-green algae] *Aphanizomenon flos-aquae* and *Microcystis aeruginosa* that are part of the periphyton assemblage (Asarian et al. 2014). The periphyton community established between Seiad Valley (RM 132.7) and Happy

[107] A periphyton community is comprised of all the species of algae found when sampling a section of the streambed, including both attached periphyton species and free-floating, un-attached algae species that may be associated with the attached periphyton species.

Camp (RM 108.3), shows strong seasonal trends, with a high diatom, low cyanobacteria [blue-green algae] community dominant until June, followed by a community that is more tolerant of low dissolved oxygen concentrations and exhibits higher cyanobacteria [blue-green algae] biomass during August through October (Asarian et al. 2014). Nitrogen-fixing species are not present directly downstream from Iron Gate Dam, but begin to appear by Seiad Valley and then make up an increasing percentage of periphyton biomass at sites farther downstream (Asarian et al. 2010; E. Asarian, pers. comm. 2011; Asarian et al. 2014, 2015). There is also seasonal variation evident in the periphyton community from Happy Camp (RM 108.3) to the Klamath River Estuary (RM 2), with the majority of periphyton falling into the high diatom, low blue-green algae community in May and June, then transitioning in July to a periphyton community comprised primarily of nitrogen-fixing diatom and blue-green algae species (i.e., species that can use nitrogen from the atmosphere). The three main nitrogen-fixing diatoms in the periphyton community beginning in July and continuing through October are *Epithemia sorex*, *Epithemia turgida*, and *Rhopalodia gibba,* which all contain cells of cyanobacteria [blue-green algae] that live inside the diatom cells to help the diatoms fix nitrogen. The main nitrogen-fixing cyanobacteria [blue-green algae] species in the periphyton community from July to October is *Calothrix* sp., a species of cyanobacteria [blue-green algae] that grows as pronounced tapering filaments (i.e., threads) attached to the streambed and rocks (Asarian et al. 2014, 2015). The nitrogen-fixing diatom and blue-green algae periphyton community dominates in the Lower Klamath River between August and October, which coincides with very low levels of inorganic nitrogen (ammonia and nitrate) concentrations in water samples (Asarian et al. 2010, 2014, 2015).

Variations in periphyton communities in the Middle and Lower Klamath River are influenced by both nutrient concentrations and flow conditions. The overall longitudinal pattern in periphyton communities described above is driven by changes in nutrient concentrations in the Middle and Lower Klamath River. Nutrient concentrations tend to decrease in a downstream direction due to nutrient retention dynamics (e.g., nutrients being used and retained in biomass) along the Middle and Lower Klamath River and dilution, as tributaries with lower nutrient concentrations flow into the Klamath River (Asarian and Kann 2013). As nutrient concentrations decrease and less nutrients are available in the water for periphyton growth, the percentage of nitrogen-fixing periphyton in the periphyton community increases, because those species are able to overcome the nitrogen limitations in the Middle and Lower Klamath River waters by using nitrogen from the atmosphere. While nutrient concentrations decrease from upstream to downstream, the overall periphyton biomass tends to increase due to these nitrogen-fixing periphyton species (Asarian et al. 2015; Gillet et al. 2016). Variations in the periphyton community during the year correspond to changes in flow in the Klamath River, with higher flow associated with a lower abundance of nitrogen-fixing periphyton. These variations are most pronounced in late summer (after July) and at locations in the Lower Klamath River (Gillet et al. 2016). As an example, the percent of the periphyton community comprised of nitrogen-fixing periphyton at the Turwar Klamath River site decreased from approximately 80 percent at flows less than approximately 3,000 cfs, to approximately 20 percent at flows greater than 10,000 cfs (Gillet et al. 2016).

Cladophora sp. have been noted to dominate the periphyton community at a Shasta River (tributary) site, where this species made up 50 percent of the periphyton community by biovolume; however, *Cladophora* sp. were not documented at any of the other tributary or mainstem Klamath River sites surveyed between September 1 and 2, 2004 (Eilers 2005). The abundance of *Cladophora* sp. in the Klamath River found in

Eilers (2005) was likely influenced by a release from Iron Gate Dam that increased the flow in the Klamath River one week prior to the study from approximately 700 cfs to 1,100 cfs for several days before decreasing to approximately 900 cfs. The increased flow may have dislodged *Cladophora* sp. and other periphyton, resulting in lower abundances than would have occurred before that release. As discussed previously (Section 3.4.2.2 *Periphyton*), *Cladophora* sp. provide suitable habitat for the polychaete worm that is the intermediate host for fish parasites. However, data regarding *Cladophora* biomass are limited, making it difficult to determine the primary factors that control the biomass and distribution of these species (E. Asarian, pers. comm., 2011). While periphyton has been studied in the Klamath River and *Cladophora* sp. has been detected in those studies, the methods used for the sampling was not designed to adequately characterize filamentous algae like *Cladophora* sp. (Asarian et al. 2014, 2015).

3.4.2.5 Klamath River Estuary

The algal community in the Klamath River Estuary is dominated by phytoplankton, although it does exhibit relatively greater amounts of periphyton in the upper portion of the estuary where conditions are more riverine. The presence of brackish water influences the types of phytoplankton and periphyton present in different areas of the estuary. Similar to the Lower Klamath River, the Klamath River Estuary phytoplankton community is composed primarily of diatoms and blue-green algae (Fetcho 2007, 2008, 2009). Phytoplankton densities are more frequently lower in the estuary than those measured concurrently in the Lower Klamath River, but phytoplankton cell densities are occasionally higher in the estuary than measured upstream. Between 2010 and 2015 when *Microcystis aeruginosa* was concurrently detected at the Klamath River Estuary and Turwar (i.e., the Lower Klamath River site upstream of the estuary), *Microcystis aeruginosa* was lower in the estuary than at the upstream site in 57 percent (12 of 21) of measurements. However, *Microcystis aeruginosa* was higher in the estuary than upstream in 43 percent (9 of 21) of measurements, so there is not always a decreasing trend in *Microcystis aeruginosa* cell densities between the Lower Klamath River and the Klamath River Estuary (Gibson 2016).

Phytoplankton sampling of the lower estuary surface by the Yurok Tribe since 2005 has indicated that blue-green algae concentrations peak annually between August and October (Fetcho 2006, 2007, 2008, 2009, 2011; Sinnott 2011, 2012; Hanington and Torso 2013; Hanington and Stawasz 2014; Hanington and Cooper-Carouseli 2014; Gibson 2016). Concentrations of *Microcystis aeruginosa* measured between 2010 and 2015 further support that trend, with annual peaks occurring primarily between August and October (Figure 3.4-16; Gibson 2016).

Blue-green algae concentrations, especially *Microcystis aeruginosa*, in the Klamath River Estuary have exceeded 2010 CCHAB, 2016 CCHAB, WHO, and Yurok Tribe blue-green algae thresholds and guidelines multiple times since 2005 (Fetcho 2006, 2007, 2008, 2009, 2011; Sinnott 2011, 2012; Hanington and Torso 2013; Hanington and Stawasz 2014; Hanington and Cooper-Carouseli 2014; Gibson 2016). On one occasion in September 2005, blue-green algae cell density exceeded the WHO guidelines for low risk recreational use (20,000 cells/mL), with instances of elevated levels of *Microcystis aeruginosa* corresponding to elevated levels measured at upstream locations in the Lower Klamath River (Fetcho 2006, 2008). In September 2007, estuary *Microcystis aeruginosa* cell density twice exceeded the then-current Yurok Tribe posting action level

(40,000 cells/mL). Yurok Tribe posting guidelines have been revised since 2007 and a caution posting currently occurs after detection of *Microcystis aeruginosa* cells (see Section 3.2.3.1 *Thresholds of Significance* and 3.4.2.1 *Phytoplankton*). In 2010 to 2014, *Microcystis aeruginosa* was detected every year, with *Microcystis aeruginosa* cell densities greater than the 2016 CCHAB threshold of 4,000 cells/mL total potentially toxigenic cyanobacteria [blue-green algae] at least once every year (Figure 3.4-16). However, *Microcystis aeruginosa* was not detected in surface samples of the Klamath River Estuary during 2015, even though it was detected upstream in the Lower Klamath River (Gibson 2016).

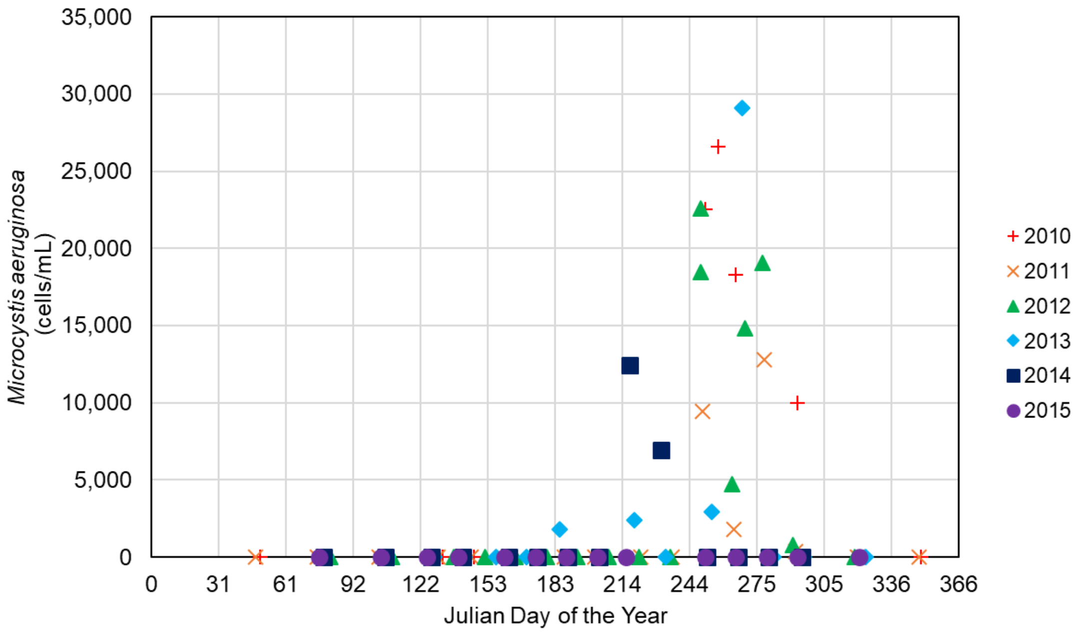

Figure 3.4-16. *Microcystis aeruginosa* cell density in the Klamath River Estuary between 2010 and 2015. Source: adapted from Gibson 2016.

Although periphyton data for the estuary are unavailable, in part due to the difficulty of sampling in deeper areas, abundant periphyton cover has been documented in the south slough (Hiner 2006).

3.4.2.6 Pacific Ocean Nearshore Environment

The algal community of the nearshore Pacific Ocean is dominated by marine algae, including attached red and brown seaweeds, as well as many marine planktonic species. The freshwater algae discussed in Section 3.4.2 *Phytoplankton* are not expected to thrive in the turbulent, saline marine environment, but they may be carried into the ocean with the current and survive for limited periods. Toxins can also be washed into the ocean, but they are expected to be rapidly diluted. There have been no reports of problems relating to freshwater algal toxins in the Pacific Ocean near the mouth of the Klamath River. However, microcystin has been reported as the cause for numerous deaths of sea otters, a federally-listed species, in the vicinity of Monterey Bay, California. Miller et al. (2010) presented evidence that microcystin produced by *Microcystis aeruginosa* in freshwater streams and lakes flowed out into the Pacific Ocean nearshore environment in Monterey Bay, California, and bioaccumulated in marine invertebrates (e.g., clams) that are a sea otter food source. Sea otter deaths due to microcystin exposure were attributed to consumption of microcystin contaminated marine invertebrates, rather than direct exposure to microcystin in freshwater, because most sea otters that died from microcystin were recovered near embayments, harbors, or river mouths. Further, sea otters do not venture into rivers to feed (Miller et al. 2010).

3.4.3 Significance Criteria

For purposes of this EIR, impacts of the Proposed Project related to phytoplankton and/or periphyton would be significant if they were to result in the following:

- An increase in the spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton blooms. The nuisance and/or noxious phytoplankton blooms in the Area of Analysis are comprised of the blue-green algae species *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, and *Microcystis aeruginosa*.
- An increase in the spatial extent, temporal duration, or biomass of nuisance periphyton species that results in new or further impairment of designated beneficial uses (Table 3.2-2). The nuisance periphyton species in the Area of Analysis is *Cladophora* sp.

For this EIR's phytoplankton and periphyton analysis, short-term is defined as the period during pre-dam removal activities, reservoir drawdown, dam removal, and associated sediment flushing events that could transport sediment-associated nutrients, which could influence phytoplankton or periphyton growth. This period corresponds to pre-dam removal years 1 and 2, dam removal year 1, dam removal year 2, and post-dam removal year 1 (Table 2.7-1). Long-term is defined as occurring after post-dam removal year 1 (i.e., greater than three years after dam removal begins).

3.4.4 Impact Analysis Approach

Existing information regarding blue-green algae blooms in the Area of Analysis for phytoplankton and periphyton suggests that several critical factors affect the frequency and toxicity of blue-green algae blooms in the Lower Klamath Project reservoirs: water temperature, light levels (FERC 2007), flow rates (Kann 2006; Asarian and Kann 2013), nutrient availability/ratios (Chorus and Bartram 1999; Fetcho 2008; Moisander et al. 2009, Asarian and Kann 2011), and wind-induced turbulence and mixing.

The assessment of the effects of the Proposed Project on phytoplankton and periphyton, especially toxic blue-green algae blooms, in the Klamath River reaches in the Area of Analysis is based on the expected effects of dam removal on water temperature, light availability, hydrodynamic conditions (water movement), nutrient availability, streambed scour conditions, and transport of blue-green algae cells in the reservoirs downstream of the dams. Existing model output and empirical data describing the expected effects of dam removal on water quality (see Section 3.2.4 *Impact Analysis Approach*) provide the basis for the anticipated effects on water temperature, suspended sediment concentrations, and nutrients. In combination with existing literature regarding the biology and ecology of blue-green algae species, the water temperature and nutrient information is used to determine whether the Proposed Project would alter the spatial extent of optimal habitat in the Area of Analysis for blue-green algae or periphyton.

Suspended sediment concentrations were used to evaluate the relative magnitude and timing of potential sediment-associated nutrients available in the river during transport of reservoir sediment deposits under the Proposed Project. Light availability that would alter photosynthesis and growth for phytoplankton and periphyton also was qualitatively assessed from expected suspended sediment concentrations, with light availability, photosynthesis, and growth potential decreasing as suspended sediment concentrations increase.

The following specific metrics are evaluated:

- The extent to which monthly mean and maximum water temperatures would be within the range of 64 to 77°F or exceed 82°F;
- Total suspended sediment and nutrient concentrations; and,
- The presence or absence of lacustrine (i.e., lake- or reservoir-like) conditions.

The water temperature range of 64 to 77ºF has been selected because the algal toxin content in cyanobacteria [blue-green algae] cells is the highest within this range and the algal toxin content decreases at water temperatures greater than 82ºF (Van Der Westhuizen and Eloff 1985; Chorus and Bartram 1999; State Water Board et al. 2010, updated 2016). Suspended sediment and nutrient concentration data are based on output from the SRH-1D model and the California Klamath River TMDLs model, respectively (see Section 3.2.4 *Impact Analysis Approach* and Appendix D for descriptions of these numeric models).

The potential effects of the Proposed Project on periphyton growth were evaluated using information about nutrients in the Klamath River presented in Asarian et al. (2010), which quantified nutrient loads and nutrient retention (seasonal removal and/or release) rates in reaches of the Klamath River. Asarian et al. (2010) estimated daily nutrient concentrations from measurements occurring monthly or more frequently using five different methods, including two constant flow-weighted-mean concentration methods, a linear interpolation method, and two regression methods. Nutrient loads (metric tons/day) for each surface inflow and outflow of individual reaches of the Klamath River and its tributaries were then estimated using the daily estimated nutrient concentrations (mg/L) and the daily mean flows (cfs). See Asarian et al. (2010) for further explanation of the method details, including equations. Table 3.4-2 presents five nutrient load estimates for each reach based on the five different methods of estimating the daily nutrient concentrations and highlights how the mean daily nutrient load estimate is similar regardless of the method used to estimate the daily nutrient concentration. A nutrient mass balance on individual reaches of the Klamath River assumes mass is never destroyed (i.e., conserved) and the nutrient mass that stays in a river reach (e.g., via uptake by periphyton, aquatic plants, or bacteria, burial in streambed sediments, sediment sorption) is equal to the nutrient mass that enters a river reach (e.g., nutrient mass from the mainstem Klamath River plus any nutrients from an incoming tributary in that reach) minus the nutrient mass exiting a river reach (e.g., transported to downstream reaches, lost to atmosphere) (Asarian et al. 2010).

Table 3.4-2. Daily Mean Nutrient Loads at Mainstem Klamath River and Major Tributary Sites Calculated Using the Five Different Methods to Estimate Daily Nutrient Concentrations. Source: Asarian et al. (2010).

Parameter	Site	River Mile	Mean Daily Load (metric tons/day)				
			Method 1 [a]	Method 2 [b]	Method 3 [c]	Method 4 [d]	Method 5 [e]
Total Phosphorus	KR downstream of Keno	237.1	0.4475	0.4513	0.4969	0.5209	0.5004
	KR upstream of Copco No. 1	211.2	0.4717	0.4814	0.5210	0.4986	0.4969
	KR downstream of Iron Gate Dam	192.7	0.4227	0.4392	0.4656	0.4647	0.4656
	KR at Walker	158.7	0.5131	0.5351	0.5311	0.5372	0.5361
	KR at Seiad Valley	131.5	0.4546	0.4989	0.4905	0.4818	0.4827
	KR at Orleans	59.6	0.4678	0.5018	0.4954	0.5016	0.4973
	KR upstream of confluence with Trinity River	43.5	0.3776	0.4330	0.4351	0.4231	0.4302
	KR downstream of confluence with Trinity River	42.6	0.4454	0.4644	0.4711	0.4623	0.4616
	KR Turwar	5.9	0.4312	0.4427	0.4560	0.4385	0.4515
	Shasta River	179.5	0.0312	0.0313	0.0315	0.0317	0.0316
	Scott River	145.1	0.0146	0.0124	0.0092	0.0081	0.0075
	Salmon River	66.3	0.0105	0.0108	0.0105	0.0122	0.0115
	Trinity River	43.3	0.0551	0.0370	0.0390	0.0364	0.0366

Parameter	Site	River Mile	Mean Daily Load (metric tons/day)				
			Method 1 [a]	Method 2 [b]	Method 3 [c]	Method 4 [d]	Method 5 [e]
Total Nitrogen	KR downstream of Keno	237.1	3.8323	4.2694	4.8199	4.8448	4.7893
	KR upstream of Copco No. 1	211.2	4.7357	4.8690	4.4496	4.3721	4.3260
	KR downstream of Iron Gate Dam	192.7	3.2693	3.3356	2.8999	2.9139	2.8961
	KR at Walker	158.7	2.9650	3.0403	3.0890	3.0670	3.0585
	KR at Seiad Valley	131.5	2.6942	2.9729	2.8540	2.7857	2.8295
	KR at Orleans	59.6	2.4052	2.6056	2.5633	2.5992	2.5723
	KR upstream of confluence with Trinity River	43.5	2.1048	2.2819	2.3388	2.2290	2.3104
	KR downstream of confluence with Trinity River	42.6	2.4566	2.5135	2.5667	2.4359	2.4804
	KR Turwar	5.9	2.6533	2.7568	2.7448	2.6937	2.7513
	Shasta River	179.5	0.0917	0.0829	0.0834	0.0874	0.0848
	Scott River	145.1	0.1269	0.1273	0.1301	0.1450	0.1308
	Salmon River	66.3	0.1000	0.0926	0.0987	0.1008	0.0925
	Trinity River	43.3	0.5404	0.3651	0.3694	0.2170	0.2173

[a] Constant flow-weighted-mean concentration (flow-weighted average of concentration from sampled days multiplied by the mean flow over the entire period).
[b] Constant flow-weighted-mean concentration within low and high-flow strata (above and below the mean flow for the entire period).
[c] Linear interpolation of concentrations between sampling dates (used in Asarian and Kann [2006]).
[d] Regression without residual (observed minus predicted values) interpolation.
[e] Regression with residual interpolation to incorporate relationships between concentration, flow and season, as well as adjacent sample points.

Anticipated changes in water quality (i.e., water temperature, suspended sediment concentrations, and nutrients) between conditions under the Proposed Project and existing conditions during the growth season (i.e., summer and early fall) in the reaches where the Lower Klamath Project reservoirs are located and at various in-river locations within the phytoplankton and periphyton Area of Analysis are also used to evaluate Proposed Project-induced changes on other phytoplankton (e.g., diatoms) and periphyton.

This analysis will then inform comparison of phytoplankton and periphyton conditions under the Proposed Project with the existing condition described above. To the extent that there is an increase in the periphyton as defined in the significance criteria, the analysis will consider whether these changes would affect a new or further impairment of designated beneficial uses.

3.4.5 Potential Impacts and Mitigation

3.4.5.1 Phytoplankton

Potential Impact 3.4-1 Short-term increase in growth of nuisance and/or noxious phytoplankton blooms due to increases in sediment-associated nutrients from release of sediments currently trapped behind the Lower Klamath Project dams.
Under the Proposed Project, J.C. Boyle Reservoir would be removed in Oregon and Iron Gate, Copco No. 1, and Copco No. 2 reservoirs would be removed in California, and sediment accumulated behind each dam would be released and transported downstream through the Klamath River and into the Pacific Ocean (see Section 3.2.5.2 *Suspended Sediments* and Potential Impacts 3.11-5 and 3.11-6). By calendar year 2020, the total amount of sediment expected to have been deposited behind J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams is approximately 15.1 million cubic yards (Table 2.7-10), with modeling indicating that reservoir drawdown would erode and transport between 36 and 57 percent of the reservoir sediment (between 5.4 and 8.6 million cubic yards) downstream through the Klamath River (Table 2.7-11). Large quantities of sediment would remain in place after dam removal, primarily on areas above the active channel of the Klamath River and these remaining reservoir sediments would dry out, decrease in thickness, and stabilize within the historical reservoir footprints (see Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown* for more details). Reservoir sediments consist primarily of fine and sand sediments (see Table 2.7-9) with the fine sediments mostly an accumulation of silt-size particles of organic material from dead and decaying algae and silt-size inorganic particles of rock (USBR 2012). Sediment-associated nutrients that have accumulated in the sediment deposits are primarily from dead algae and are typically bound to the fine sediments (Deas 2008, Downs et al. 2010, USBR 2012).

Short-term increases in sediment-associated nutrients could occur in the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary due to the release of sediments currently trapped behind the dams (see Potential Impact 3.2-7). While there would be a short-term increase in sediment-associated nutrients, minimal deposition of fine suspended sediments, including the associated nutrients, would occur in the river channel and the estuary (Stillwater Sciences 2008; USBR 2012). Thus, the short-term increase in nutrients would be limited to the time period when sediment deposits are being transported through the Klamath River. The reservoir drawdown and release of these nutrients would occur during winter months when the rates of phytoplankton growth and reproduction, which require nutrients, are relatively low. As a result, the ability of phytoplankton to use sediment-associated nutrients mobilized during reservoir drawdown would be low and the Proposed Project would not be likely to stimulate an increase in phytoplankton growth or reproduction. Sediment released during reservoir drawdown under the Proposed Project also would increase suspended sediment concentrations and water turbidity (Potential Impact 3.2-3), limiting light availability for phytoplankton photosynthesis and further reducing the potential for additional phytoplankton growth and reproduction.

Further, by mid- to late-spring when phytoplankton would have begun to bloom in the calm Lower Klamath Project reservoir habitat, reservoir drawdown would be complete and the riverine concentration of suspended sediments (see Potential Impact 3.2-3) and the additional sediment-associated nutrients (see Potential Impact 3.2-7) would be low. The minimal deposition of fine suspended sediments, including associated nutrients, in the river channel and the estuary (Stillwater Sciences 2008; USBR 2012) could provide nutrients for phytoplankton growth. However, because higher velocity river conditions would replace the slower-moving reservoir habitat in the Hydroelectric Reach after drawdown, there would be limited suitable habitat for phytoplankton growth and reproduction, regardless of any sediment-associated nutrients that may be deposited in the river channel or the estuary during drawdown. Phytoplankton, especially cyanobacteria [blue-green algae], growth is highest in stable water column conditions (Konopka and Brock 1978; Kann 2006; Asarian and Kann 2011) and the abundance of cyanobacteria [blue-green algae] decreases compared to other phytoplankton (e.g., diatoms and green algae) when mixing in a water body increases (McDonald and Lehman 2013; Visser et al. 2016). The lack of suitable habitat in the Hydroelectric Reach in mid- to late-spring would limit phytoplankton growth and reproduction, even with any sediment-associated nutrients that may be present. Furthermore, the reaches of the Hydroelectric Reach where the reservoirs are located would no longer transport high concentrations of nuisance and/or noxious phytoplankton species from phytoplankton blooms in the reservoirs into the Middle and Lower Klamath River and the Klamath River Estuary under the Proposed Project (Potential Impact 3.4-2), so phytoplankton growth and reproduction also would be limited in these reaches, even with any sediment-associated nutrients.

Additional movement of reservoir sediment deposits not mobilized during drawdown in dam removal year 2 may occur during winter high flows in post-dam removal year 1, resulting in additional transport of sediment-associated nutrients. However, nuisance and/or noxious phytoplankton blooms would not be stimulated by these nutrients, since they would occur during winter months when growth, reproduction, and nutrient transformation rates would be low, suspended sediment during transport of sediment-associated nutrients would limit light availability for phytoplankton growth, and calm, slow-moving habitat for phytoplankton would be limited. Winter high flows during post-dam removal year 1 would be likely to transport some sediments from remaining reservoir sediment deposits, although this would be limited due to revegetation of the reservoir footprints (Potential Impact 3.2-3) and the reasons identified above (e.g., limited light and faster-moving water) that would generally limit potential phytoplankton growth during winter flows. Thus, there would be minimal deposition of fine sediments and associated nutrients in the river channel and the estuary and negligible stimulation of phytoplankton growth later in post-dam removal year 1 in associated with sediment export related to the Proposed Project.

For the reasons stated above, phytoplankton growth and reproduction would not be increased by mobilization of sediment-associated nutrients during dam removal year 2 (i.e., reservoir drawdown) and post-dam removal year 1. Accordingly, the Proposed Project would not increase the spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton blooms in the Hydroelectric Reach, Middle and Lower Klamath River, or the Klamath River Estuary, and there would be no short-term impact.

Significance

No significant impact

Potential Impact 3.4-2 Alterations in the spatial extent, temporal duration, transport, or concentration of nuisance and/or noxious phytoplankton blooms and concentrations of algal toxins due to dam removal and elimination of reservoir habitat.

Hydroelectric Reach

The removal of the Lower Klamath Project dams and reservoirs, particularly the larger Copco No. 1 and Iron Gate reservoirs, would decrease or eliminate support for excessive growth of blue-green algae (i.e., blooms) over the long term by eliminating large areas of quiescent habitat where these phytoplankton species currently thrive. In the nutrient-rich Klamath River system, the elevated water temperatures and increased light levels that occur during the summer and early fall result in seasonal blue-green algae blooms in the phytoplankton and periphyton Area of Analysis, and especially the Hydroelectric Reach (Section 3.4.2.3 *Hydroelectric Reach*). In addition to Copco No. 1 and Iron Gate reservoirs, riverine reaches downstream of the reservoirs generally experience high abundance of *Microcystis aeruginosa*, with the highest cell densities and microcystin toxin concentrations occurring directly downstream of Iron Gate Reservoir (see Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*, Section 3.4.2.4 *Middle and Lower Klamath River*, and Appendix C – C.6.2 *Mid- and Lower Klamath Basin*). Available data strongly indicate that the reservoirs provide ideal conditions for blue-green algae blooms and serve as a source of blue-green algae cells and their toxins (e.g., microcystin) to downstream areas. While cyanobacteria [blue-green algae] can occur in riverine and estuarine environments (Christian et al. 1986, Lehman et al. 2005, Lehman et al. 2008), the rate of turbulent mixing in the water column relative to the flotation velocity of cyanobacteria [blue-green algae] is a critical factor controlling the size of cyanobacteria [blue-green algae] blooms (Huisman et al. 2004). Numerous studies in water bodies around the world have documented how blue-green algae tend to dominate the phytoplankton community in environments with low turbulent mixing (e.g., lakes, reservoirs). However blue-green algae abundance compared to other phytoplankton (e.g., diatoms and green algae) decreases as water column mixing increases because the net growth rate of blue-green algae decreases as they are mixed into the deeper water column where there is greater light variation and less overall light availability for photosynthesis. In addition to less overall light availability, Mitrovic et al. (2003) reports that the variation in light availability cyanobacteria [blue-green algae] would experience in a turbulent river mixing environment would reduce *Microcystis aeruginosa* and *Anabaena* growth compared to other phytoplankton species (e.g., diatoms and green algae). Under turbulent mixing conditions, cyanobacteria [blue-green algae] also face more competition from other phytoplankton that can remain suspended in the water column, compete for available light, and increase their net growth rate relative to cyanobacteria [blue-green algae] (Visser et al. 2016).

The Proposed Project would dramatically decrease the amount of optimal (i.e., calm, slow-moving reservoir) habitat available for the growth of nuisance and/or noxious phytoplankton species in the Hydroelectric Reach, resulting in a corresponding decrease in phytoplankton blooms compared to under existing conditions. After reservoir drawdown finishes, the calm, slow-moving reservoir habitat would be replaced by higher velocity riverine conditions, with limited suitable habitat for phytoplankton growth and reproduction. Higher mixing conditions would especially decrease blue-green algae abundance, since the increases in mixing would decrease the overall light availability for growth and reproduction compared to calm conditions where these organisms can remain exclusively near the water surface. Diatoms and green algae tend to grow better in turbulent river conditions than calm lake conditions, so blue-green algae also would be out-competed by these other phytoplankton. The lack of suitable habitat would substantially reduce seasonal phytoplankton bloom occurrence, especially blue-green algae blooms, and the associated production of algal toxins that are potentially harmful to animals and humans and impair designated beneficial uses. While the nutrients currently entering the Hydroelectric Reach may continue to be available to organisms in the Klamath River following dam removal, phytoplankton, especially blue-green algae, would be limited in their ability to use those nutrients for growth and reproduction without calm reservoir habitat. Cyanobacteria [blue-green algae] do not dominate under the current nutrient conditions in the turbulently mixing Klamath River downstream of J.C. Boyle Reservoir and upstream of Copco No. 1 Reservoir (Kann and Asarian 2006), so blue-green algae also would not be expected to dominate in the new turbulently mixed river reaches formed when Copco No. 1 and Iron Gate dams are removed. Under the Proposed Project, reductions in nuisance and/or noxious phytoplankton blooms, due to the elimination of the reservoirs in the Hydroelectric Reach, would be beneficial.

Drawdown of the reservoirs would begin in winter and would be largely complete by March/April (i.e., the beginning of the growth season) of dam removal year 2, so complete elimination of the reservoir environment would occur by the end of dam removal year 2 under the Proposed Project. Thus, the reductions in nuisance and/or noxious phytoplankton blooms would also occur by the end of dam removal year 2 in the Hydroelectric Reach and this would be a short-term benefit as well as a long-term benefit.

Middle and Lower Klamath River

Under the Proposed Project, nuisance and/or noxious phytoplankton blooms and concentrations of algal toxins would be expected to decrease in the Middle and Lower Klamath River, because the removal of Copco No. 1 and Iron Gate reservoirs would eliminate the primary source of Microcystis aeruginosa in the Middle and Lower Klamath River downstream of Iron Gate Dam. Existing data indicate blue-green algae (e.g., Microcystis aeruginosa) and associated algal toxins (e.g., microcystin) in the Middle and Lower Klamath River downstream of Iron Gate Dam do not result from transport of blue-green algae or algal toxins from upstream sources (i.e., Upper Klamath Lake), but originate from large seasonal blue-green algae blooms in Iron Gate and potentially Copco No. 1 reservoirs (see Section 3.4.2.3 *Hydroelectric Reach*, Section 3.4.2.4 *Middle and Lower Klamath River*, and Appendix C – *Section* C.6 *Chlorophyll-a and Algal Toxins*). Large seasonal blue-green algae blooms occurring upstream of the Area of Analysis are removed from the Upper Klamath River by upstream processes (e.g., settling in Keno Reservoir, microbial degradation) as well as dilution from tributaries in the Hydroelectric Reach and natural groundwater springs occurring in the J.C. Boyle Bypass Reach (see Section 3.2.2.3 *Suspended Sediments* and Appendix C – Section C.2.1.1 *Hydroelectric Reach*). *Microcystis aeruginosa* are typically not detected immediately upstream of Copco No. 1, but measurements of *Microcystis aeruginosa* taken at sampling locations in Copco No. 1 and Iron Gate reservoirs on the same day as the upstream measurements did occasionally detect large blooms of *Microcystis aeruginosa*, supporting the conclusion *Microcystis aeruginosa* blooms are primarily originating in those reservoirs. *Microcystis aeruginosa* was detected in only 2 of 17 measurements at the Klamath River station just upstream of Copco No. 1 Reservoir near the confluence with Shovel Creek ("KRAC" monitoring location in Figure 3.4-2) from 2001 to 2004 (Kann and Asarian 2006) and no detections were reported in data from 2005 (Kann and Asarian 2007), 2006 (Kann and Corum 2007), 2007 (Kann 2007), and 2008 (Kann and Corum 2009). However, three detections of *Microcystis aeruginosa* (in

79 measurements) were reported upstream of Copco No. 1 Reservoir near the confluence with Shovel Creek in a compilation of data from 2005 to 2010, with two measurements in 2007 and one measurement in 2008 (Asarian and Kann 2011). Those three measurements of *Microcystis aeruginosa* occurred in October or November after *Microcystis aeruginosa* had peaked in Copco No. 1 and Iron Gate reservoirs. Furthermore, genetic analysis of cyanobacteria [blue-green algae] populations in Copco No. 1 and Iron Gate reservoirs indicate the cyanobacteria [blue-green algae] found in the Middle and Lower Klamath River are similar to those found in Iron Gate Reservoir and not due to transport of cyanobacteria [blue-green algae] populations from Copco No. 1 Reservoir or farther upstream (Otten et al. 2015).

Microcystin trends in the Hydroelectric Reach and Middle and Lower Klamath River (see Appendix C, Figures C-52 and C-53 for details) also support the conclusion that microcystin detected downstream of Iron Gate Dam is not the result of transport from upstream sources (i.e., Upper Klamath Lake), but originates from large seasonal blue-green algae blooms in Iron Gate and potentially Copco No. 1 reservoirs. Microcystin toxin rarely persists in the Upper Klamath River under current conditions due to upstream removal mechanisms. Adsorption onto both suspended and streambed sediments (e.g., clay particles), breakdown by sunlight (i.e., photodegradation), and microbial degradation are several key microcystin removal mechanisms in natural freshwater and marine environments (Schmidt et al. 2014). Measured microcystin concentrations within Copco No. 1 and Iron Gate reservoirs have annually exceeded the CCHAB threshold 0.8 ug/L total microcystin between 2009 and 2018, with peak concentrations often exceeding 10 ug/L total microcystin multiple times per year and exceeding 100 ug/L total microcystin in both reservoirs between 2014 and 2017 (Watercourse Engineering Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; E&S Environmental Chemistry, Inc. 2013, 2014, 2015, 2016, 2018a, 2018b). While microcystin was greater than the 2016 CCHAB threshold in Copco No. 1 and Iron Gate reservoirs, in the Klamath River upstream of Copco No. 1 microcystin was typically below detectable concentrations with infrequent measurements above the 2016 CCHAB threshold of 0.8 ug/L total microcystin (see also Figure 3.4-13; Kann and Asarian 2006, 2007; Kann 2007; Kann and Corum 2007, 2009; Watercourse Engineering Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Otten et al. 2015). The frequency of higher microcystin measured in Copco No. 1 and Iron Gate reservoirs than upstream of Copco No. 1 Reservoir strongly supports data that *Microcystis aeruginosa* blooms within the reservoirs are the source of microcystin in the two reservoirs and in the Klamath River downstream of Iron Gate Dam rather than microcystin being transported into the reservoirs from upstream.

Under the Proposed Project, turbulence and higher velocities would occur in the Hydroelectric Reach where the calm, slow-moving waters of Copco No. 1 and Iron Gate reservoirs currently exist, and these conditions would potentially provide additional removal of *Microcystis aeruginosa* from upstream sources, which would also reduce associated microcystin concentrations. The calm, slow-moving reservoir habitat that supports seasonal nuisance and/or noxious phytoplankton blooms in the Hydroelectric Reach would be eliminated and the available data suggests that large blooms of *Microcystis aeruginosa* from upstream would not be transported through the Hydroelectric Reach into the Middle Klamath River and further downstream reaches. Therefore, the overall occurrence of nuisance and/or noxious phytoplankton blooms and associated toxins in the Middle and Lower Klamath River would be substantially reduced or eliminated. Drawdown of the reservoirs would begin in winter and would be largely complete by March/April (i.e., the beginning of the growth season) of dam removal year 2, so complete elimination of the reservoir environment would occur by the end of dam removal year 2 under the Proposed Project. Thus, the reductions in nuisance and/or noxious phytoplankton blooms transported downstream from the reservoirs would also occur by the end of dam removal year 2 and this would be a short-term benefit as well as a long-term benefit.

Long-term increases in annual total nutrient levels would occur in the Middle and Lower Klamath River due to the lack of continued interception of nutrients by the Lower Klamath Project dams (Potential Impact 3.2-8). However, possible summer and fall increases in nutrient concentrations following Lower Klamath Project dam removal (see Section 3.2.5.3 *Nutrients*), particularly directly downstream from Iron Gate Dam, would not substantially contribute to blue-green algae blooms downstream from the dam, due to the lack of the suitable habitat conditions required for extensive phytoplankton growth in the Klamath River (see discussion above under the Hydroelectric Reach). Some phytoplankton growth may still occur after dam removal in calm, slow-moving habitats along shorelines and protected coves and backwaters during low-flow periods in the Middle and Lower Klamath River, but these habitats already support growth of blue-green algae, including *Microcystis aeruginosa*, that results in occasional exceedances of 2016 CCHAB secondary thresholds and WHO guidelines (Falconer et al. 1999; Kann et al. 2010; State Water Board et al. 2010, updated 2016; Genzoli and Kann 2016, 2017). While total nutrient transport into the Middle and Lower Klamath River after dam removal would slightly increase under the Proposed Project, *Microcystis aeruginosa* cell density and microcystin concentrations in Middle and Lower Klamath River after dam removal are expected to decrease due to reduced transport of *Microcystis aeruginosa* and microcystin from the Hydroelectric Reach into the Middle and Lower Klamath River. Therefore, the slight increase in nutrient availability is not expected to support nuisance phytoplankton growth or blooms that exceed current levels.

This analysis suggests that the Proposed Project would have a positive effect on aquatic resources in the Klamath River downstream from Iron Gate Dam in the long term based on reductions in downstream transport and concentrations of phytoplankton and microcystin toxins to this area. Overall, under the Proposed Project, long-term reductions in nuisance and/or noxious phytoplankton blooms in the reservoirs in the Hydroelectric Reach would reduce or eliminate the transport of nuisance and/or noxious phytoplankton species, blooms of these phytoplankton species, and concentrations of algal toxins (e.g., microcystin) into the Middle and Lower Klamath River and would be beneficial.

Klamath River Estuary

Information relating current conditions of phytoplankton biomass, population dynamics, and nutrient limitation to phytoplankton growth in the Klamath River Estuary is limited even though blue-green algae cell concentrations are monitored monthly to bi-weekly during much of the year (Fetcho 2006, 2007, 2008, 2011; Sinnott 2011, 2012; Hanington and Torso 2013; Hanington and Stawasz 2014; Hanington and Cooper-Carouseli 2014; Gibson 2016). Consequently, it is difficult to determine the potential long-term effects that the Proposed Project would have on phytoplankton in the Klamath River Estuary. Existing information indicates that instances of elevated levels of *Microcystis aeruginosa* in the Klamath River Estuary correspond with elevated levels measured at upstream locations in the Lower Klamath River (see Section 3.4.2.5 *Klamath River Estuary*). Removal of the Lower Klamath Project would reduce or eliminate elevated

Microcystis aeruginosa levels in the Lower Klamath River (see discussion in the prior section), so levels in the Klamath River Estuary are also likely to be reduced or potentially eliminated. Klamath River tributaries may influence Klamath River Estuary cyanobacteria [blue-green algae] conditions; however, infrequent detections of low cyanobacteria [blue-green algae] concentrations and associated algal toxins at the mouth of major Klamath River tributaries downstream of Iron Gate Dam (e.g., Scott River) suggest that tributaries are a lesser influence on cyanobacteria [blue-green algae] concentrations in the Klamath River Estuary compared with the mainstem Klamath River (Kann et al. 2010).

As detailed for the Middle and Lower Klamath River, small increases in nutrient transport from the upper watershed could occur over the long term because of dam removal (Potential Impact 3.2-8). The potential nutrient increase to the Klamath River Estuary would be smaller than in the Middle and Lower Klamath River, with the Yurok Tribe analysis modeling an increase of approximately 0.15 mg/L or less total nitrogen and an increase of approximately 0.01 mg/L or less total phosphorus (see Figure 3.2-19). The Yurok Tribe analysis' estimate of nutrient increases conservatively includes assumptions that would tend to over-estimate the potential change, since it does not take into account other possible factors that may decrease nutrients upstream of Copco No. 1 Reservoir under the Proposed Project, such as TMDL implementation or elimination of peaking flows from hydropower operations. If reductions in nutrients do occur upstream of Copco No. 1 Reservoir, then there would be an even smaller long-term increase in nutrients to the Klamath River Estuary (Asarian et al. 2010).

Estimated long-term increases in nutrients to the Klamath River Estuary are less than or within current annual and inter-annual variations in nutrients, suggesting the additional nutrients would not stimulate an increase in phytoplankton growth beyond current conditions in the Klamath River Estuary. In the Klamath River Estuary between 2010 and 2014, the annual variation between maximum and minimum total nitrogen ranged from 0.28 to 0.55 mg/L, with a 0.13 to 0.18 mg/L variation in peak total nitrogen between years. The annual variation between maximum and minimum total phosphorus ranged from 0.03 to 0.15 mg/L, with a 0.01 to 0.12 mg/L variation in peak total phosphorus between years from 2010 to 2014 (Sinnott 2011b, 2012b; Hanington and Torso 2013; Hanington and Stawasz 2014; Hanington and Cooper-Carouseli 2014).

Some additional growth of nuisance and/or noxious phytoplankton species could occur in the Klamath River Estuary during summer and fall low-flow periods due to the previously mentioned small increase in nutrients. The relative increase in phosphorus would be particularly small such that the prevalence of nitrogen-fixing blue green algae species (i.e., *Aphanizomenon flos-aquae* and *Anabaena flos-aquae*) would be unlikely to change relative to existing conditions. Nitrogen availability in the water is relatively more important for *Microcystis aeruginosa* because it does not fix nitrogen from the air (Eldridge et al. 2012). Although nitrogen would also increase in the estuary water, *Microcystis aeruginosa* cell density and microcystin concentrations are likely to be the same or less than current conditions due to the lack of downstream transport of seasonal blooms of this species from Copco No. 1 and Iron Gate reservoirs. Under the Proposed Project, long-term reductions in nuisance and/or noxious phytoplankton blooms in the Hydroelectric Reach and the reduction or elimination of transport of phytoplankton cells and their associated toxins into the estuary would be beneficial for the Klamath River Estuary.

Pacific Ocean nearshore environment
The Pacific Ocean nearshore environment is not a suitable habitat for the freshwater phytoplankton species of concern (i.e., *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, *Microcystis aeruginosa*) therefore the Proposed Project would have no impact on these species. Further, nutrient increases in the Pacific Ocean nearshore environment due to the lack of continued interception by the Lower Klamath Project dams would be considerably less than the background supply of nutrients from coastal upwelling (Bruland et al. 2001; Bograd et al. 2009), so the nutrient increase is not expected to affect marine phytoplankton blooms.

Significance
Beneficial for the Hydroelectric Reach, Middle and Lower Klamath River, and Klamath River Estuary in the short term and long term

No significant impact for the Pacific Ocean nearshore environment in the short term and long term

3.4.5.2 Periphyton

Potential Impact 3.4-3 Short-term increase in growth of nuisance periphyton species due to increases in sediment-associated nutrients from release of sediments currently trapped behind the Lower Klamath Project dams.
Under the Proposed Project J.C. Boyle Reservoir would be removed in Oregon and Iron Gate, Copco No. 1, and Copco No. 2 reservoirs would be removed in California, releasing sediment accumulated behind each dam and transporting the sediment downstream through the Klamath River and into the Pacific Ocean (see 3.2.5.2 *Suspended Sediments* and 3.11.4 *Impact Analysis Approach).* Modeling indicates reservoir drawdown eroding and transporting between 5.4 and 8.6 million cubic yards of reservoir sediment downstream through the Klamath River (Table 2.7-11). Large quantities of sediment would remain in place after dam removal, primarily on areas above the active channel of the Klamath River and these remaining reservoir sediments would dry out, decrease in thickness, and stabilize in place within the historical reservoir footprints (see Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown* for more details). Reservoir sediments consist primarily of fine and sand sediments (see Table 2.7-9) with the fine sediments mostly an accumulation of silt-size particles of organic material from dead and decaying algae and silt-size inorganic particles of rock (USBR 2012). Sediment-associated nutrients that have accumulated in the sediment deposits are primarily from dead algae and typically bound to the fine sediments (Deas 2008; Downs et al. 2010; USBR 2012).

In the short term, through winter and early to mid-spring of dam removal year 2 (Table 2.7-1), periphyton growth would be unlikely to be stimulated by sediment-associated nutrients or conversion of the reservoir areas to free-flowing streams and elimination of hydropower peaking operations. Short-term increases in sediment-associated nutrients would occur in the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary due to the release of sediments currently trapped behind the dams (see Potential Impact 3.2-7). However, reservoir drawdown would occur during winter months when rates of periphyton growth and reproduction, which require nutrients, are relatively low due to less light availability for photosynthesis and lower water temperatures. As a result, the ability of periphyton to use sediment-associated nutrients would be limited and there would not be an increase in periphyton growth or reproduction during this period, even though additional nutrients would be available due to the release of sediments trapped behind the Lower Klamath Project dams. Light limitation from high concentrations of suspended sediments in the water (Potential Impact 3.2-3) would also reduce any potential for nuisance levels of periphyton growth during reservoir drawdown.

Additionally, high river flows during the winter drawdown period and late spring storm events would result in greater sediment movement and scouring under the Proposed Project (Potential Impacts 3.11-5 and 3.11-6), which would greatly limit, if not eliminate, the area of the streambed that periphyton can thrive during this period. At individual monitoring sites in the Klamath River, higher flow consistently corresponds to lower total periphyton biovolume, especially at sites with a larger variation in flows. After natural high flows due to storms, periphyton is reduced to a thin layer of scour-resistant diatoms, since some diatom species are well suited to withstand higher flows (Asarian et al. 2015). Three studies analyzed the flows required to mobilize the streambed downstream of Iron Gate Dam from the Klamath River confluence with Bogus Creek (RM 192.6) to either its confluence with the Shasta River (RM 179.5) or Blue Creek (RM 16.2) (dependent on study). An analysis of those studies indicates that under current conditions, flows between 5,000 to 8,700 cfs would move surface fine sediments on 20 to 30 percent of the streambed (i.e., surface flushing), flows between 8,700 and 11,250 cfs would move in-filled fine sediment between streambed cobbles (i.e., deep flushing), and flows between 11,250 to 15,000 cfs would move individual cobbles (i.e., armor disturbance) (Hillemeier et al. 2017). Modeling indicates that during drawdown flow downstream of Iron Gate Dam would exceed the minimum surface flushing flows for approximately one week to over one month between January and April under wet, above normal, and normal water year types, while flow would exceed the minimum armor disturbance flows for approximately one day to one week between January and February under wet and above normal water year types. Mobilization of the streambed during drawdown flows would also be expected to scour periphyton attached to the streambed sediments. This effect is particularly important for periphyton during winter because high drawdown or natural flows that move larger sediments like gravels and cobbles would limit and potentially eliminate short-term establishment of periphyton along the streambed and other underwater surfaces. This reduction in the area periphyton can establish and grow due to these high flows in winter and spring would result in decreases in the overall periphyton abundance in the river, further inhibiting uptake of sediment-associated nutrients by periphyton for growth as those nutrients are transported through the Klamath River.

Additional movement of reservoir sediment deposits not removed during drawdown in dam removal year 2 may occur during winter high flows in post-dam removal year 1 resulting in more transport of sediment-associated nutrients. However, growth of nuisance periphyton species would not be stimulated by these nutrients since they would be transported through the Klamath River during winter months when growth, reproduction, and nutrient transformation rates would be low, high flows may scour the streambed and reduce periphyton abundance, and suspended sediment during transport of sediment-associated nutrients would limit light availability for periphyton growth. Similar to conditions during reservoir drawdown, winter high flows that transport suspended sediments would result in minimal deposition of fine sediments, so minimal sediment-associated nutrients would deposit and be available to stimulate periphyton growth later in the year.

As the periphyton growth would be unaffected by mobilization of sediment-associated nutrients during dam removal year 2 (reservoir drawdown) and post-dam removal year 1, the Proposed Project would not increase the spatial extent, temporal duration, or biomass of nuisance periphyton species to the degree that new or further impairment of designated beneficial uses would occur in the Hydroelectric Reach, Middle and Lower Klamath River, or the Klamath River Estuary due to transport of sediment-associated nutrients from release of reservoir sediment deposits from behind the Lower Klamath Project dams, and there would be no short-term impact.

Significance

No significant impact

Potential Impact 3.4-4 Alterations in growth of nuisance periphyton species in the Hydroelectric Reach due to increased nutrients and available low-gradient channel margin habitat formed by conversion of the reservoir areas to a free-flowing river and the elimination of hydropower peaking operations.

Periphyton growth in low-gradient channel margin areas in the Hydroelectric Reach could increase on a seasonal basis following dam removal because removal of the reservoirs and elimination of hydropower operations in the J.C. Boyle Peaking Reach would provide additional low-gradient habitat suitable for periphyton assemblages. Dam removal, construction, and restoration activities in dam removal year 2 and sediment transport and scour during winter post-dam removal year 1 may reduce periphyton abundance and growth, but, overall, periphyton would be expected to begin colonizing the newly created suitable habitat within the short term and this colonization and growth of periphyton would continue in the long term.

The particular periphyton species that could occupy these areas are unknown (E. Asarian, pers. comm., 2011), but analysis of periphyton species downstream of Iron Gate Dam indicates the types of periphyton assemblages that could occur in the free-flowing Hydroelectric Reach under the Proposed Project (Asarian et al. 2015). The exact periphyton assemblage would be dependent primarily on nutrient availability and seasonal flow variations (Gillet et al. 2016).

Under the Proposed Project, there would be less artificial diel temperature variation during summer and early fall in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir (see also Potential Impact 3.2-1). While J.C. Boyle retains relatively little nutrients under existing conditions (see Appendix C, Section C.3.1.1 *Hydroelectric Reach*), nutrients could increase slightly if J.C. Boyle Dam is removed. However, less diel temperature variations and a slight decrease in the maximum water temperature in this reach are not anticipated to affect periphyton colonization. Additionally, the generally high gradient and velocity in the J.C. Boyle Peaking Reach does not currently support excessive periphyton mats and it is not anticipated that this reach would support excessive periphyton mats if J.C. Boyle Dam were to be removed and hydropower peaking flows were to cease. In the short term and long term, increases in periphyton biomass from elimination of peaking flows along with the change in water temperatures are expected to be limited in the Hydroelectric Reach from the Oregon-California state line to Copco No. 1 Reservoir and any potential increase in periphyton would not result in new or further impairment of designated beneficial uses. Thus, there would be a less than significant impact of the Proposed Project on periphyton colonization in this reach.

Further downstream, in the lower-gradient portions of the Hydroelectric Reach, from Copco No. 1 Reservoir to Iron Gate Dam, long-term heavy colonization of periphyton mats in the Hydroelectric Reach is unlikely as potential increases in periphyton growth could be disrupted by increased flow variability during storm flow under the Proposed Project (see also Potential Impact 3.6-3) and more frequent river bed sediment movement (see also Potential Impact 3.11-5). Removal of the Lower Klamath Project dams and reservoirs, particularly Copco No. 1 and Iron Gate reservoirs, would produce slightly higher peak flows and more flow variations because modeling indicates the Lower Klamath Project provides a slight attenuation (1.1 to 6.9 percent) of peak flood flows (USBR 2012) and storm flow variations from tributaries entering the Hydroelectric Reach are dampened by the reservoirs. Additionally, upstream fine and sand sediments currently trapped by the Lower Klamath Project reservoirs, particularly Copco No. 1 and Iron Gate reservoirs, would be transported and deposited along the Hydroelectric Reach streambed, so the flow necessary to mobilize the streambed in the existing riverine sections of the Hydroelectric Reach would be less than existing conditions. Together these processes (i.e., higher peak flows, more flow variations, and lower flow needed to move sediments) would result in more frequent sediment transport in the Hydroelectric Reach, which may result in increased scouring of periphyton during winter and spring storm events compared to existing conditions and a lower overall biomass later in the growth season (FERC 2007; North Coast Regional Board 2010, Appendix 2).

However, the overall effect of the Proposed Project would likely be to increase periphyton in the margins of low gradient portions of Copco No. 1 and Iron Gate reservoir footprints due to the creation of new, previously uncolonized low gradient river channels. While there is considerable uncertainty, there is the potential under the Proposed Project that nuisance periphyton species could be part of the periphyton assemblages that grow in the margins of these new low gradient river channels. The nuisance periphyton species would potentially provide habitat for the polychaete worm (*Manayunkia speciose*) that is the intermediate host of the fish parasites *Ceratomyxa shasta* and *Parvicapsula minibicornis,* so the short-term and the long-term increase in growth of nuisance periphyton species due to increases in available habitat along channel margin areas of the Hydroelectric Reach within the Copco No. 1 and Iron Gate reservoir footprints also would potentially result in a new or further impairment of designated beneficial uses, and would therefore be a significant impact.

The above analysis represents a conservative assessment of the effects of the Proposed Project on short-term and long-term growth of nuisance periphyton species. The response of periphyton in the Klamath River is subject to many competing processes that could either accelerate or hinder periphyton growth and potential increases in nuisance periphyton species (i.e., *Cladophora* sp.) extent, duration, and biomass. In the long term, improvements (i.e., reductions in periphyton biomass) are expected from several processes such as scour, and in-stream nutrient retention processes, but periphyton biomass reductions could be diminished by processes such as reduced nutrient retention from the loss of the reservoirs or climate change. While the growth of nuisance periphyton species along channel margin areas is not expected to contribute algal toxins that would impair water quality, the degree to which designated beneficial uses would be impaired due to an increase in nuisance periphyton species (i.e., *Cladophora* sp.) in the newly formed low-gradient channel margin areas of the Hydroelectric Reach is not fully understood. The implications of potential changes in periphyton biomass and community composition on dissolved oxygen and the spread of fish disease are described in Section 3.2.5.4 *Dissolved Oxygen* and Section 3.3.5.5 *Fish Disease and Parasites*, respectively.

Periphyton are a natural component of river ecology and they are an important element of aquatic food webs. The establishment and growth of periphyton, including nuisance periphyton species, along the margins of the newly created low gradient river channel is a natural process. While processes that influence periphyton establishment and growth have been identified (e.g., light availability, nutrient availability, water temperature, seasonal flow variations, sediment transport), variations in these processes within the Hydroelectric Reach of the Klamath River after dam removal would not completely prevent the potential for growth of nuisance periphyton species along the margins of the newly created low gradient river channels. In the reservoir areas of the Hydroelectric Reach that would become the newly created low gradient habitat, there is no periphyton since it is not suitable habitat. No mitigation measure would completely eliminate the potential for establishment and growth of periphyton or specifically nuisance periphyton within these areas. As such, there are no mitigation measures that can be proposed to significantly avoid or minimize this impact and reduce the impact to less than significant.

Significance

No significant impact for the Hydroelectric Reach from the Oregon-California state line to Copco No. 1 Reservoir in the long term

Significant and unavoidable for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam in the long term

Potential Impact 3.4-5 Alterations in biomass of nuisance periphyton species due to increased nutrients from upstream dam removal and conversion of the reservoir areas to a free-flowing river.

Middle and Lower Klamath River

As described in Section 3.4.2.4 *Middle and Lower Klamath River*, seasonal periphyton growth under existing conditions is relatively high in the Middle and Lower Klamath river (Eilers 2005). Under the Proposed Project, the Lower Klamath Project dams would no longer trap and store annual upstream nutrient inputs nor create the conditions where nutrients stored in reservoir sediments would be seasonally released downstream resulting in an anticipated overall less-than-significant long-term increase in absolute nutrient concentrations (see Section 3.2.5.3 *Nutrients*, Potential Impact 3.2-8 for more details).

The long-term increase in Total Nitrogen (TN) and Total Phosphorus (TP) are not expected to result in a significant biostimulatory effect on periphyton growth because nutrients do not appear to be limiting periphyton growth in the Klamath River from Iron Gate Dam (RM 193.1) to approximately Seiad Valley (RM 132.7) (and potentially farther downstream), N-fixing periphyton are abundant in the Lower Klamath River, and the increase in TP is minimal. While existing data regarding TN:TP ratios in the Klamath River suggest the potential for N-limitation (TN:TP <10), with some periods of co-limitation by N and P (see also Section 3.2.2.4 *Nutrients* and Appendix C – Section C.3.2 *Mid- and Lower Klamath Basin*), concentrations of both nutrients are high enough in the river from Iron Gate Dam to approximately Seiad Valley (and potentially further downstream) that periphyton growth is currently nutrient saturated. Nutrients are not likely to be limiting periphyton growth in this portion of the Klamath River (FERC 2007;

HVTEPA 2008; Asarian et al. 2010, 2014, 2015; Gillet et al. 2016) and additional upstream nutrients would not alter periphyton conditions in this reach. While there would be long-term increases in nutrients due to dam removal, seasonal (i.e., fall) downstream releases of nutrients stored in reservoir sediments would also be eliminated by removing the reservoirs and the overall magnitude of the long-term increases in nutrients available to stimulate periphyton growth downstream of the reservoirs would be less during fall. In the lower reaches of the Klamath River (i.e., downstream of approximately Seiad Valley), where inorganic nitrogen concentrations are low, N-fixing periphyton species currently dominate the periphyton communities (Asarian et al. 2010, 2014, 2015; Gillet et al. 2016). Since N-fixing species can fix their own nitrogen from the atmosphere, increases in TN due to dam removal may alter the composition of the periphyton community and shift the location where N-fixing species begin to dominate farther downstream in the Lower Klamath River (Asarian et al. 2010). However, the Proposed Project would be accompanied by only relatively minor increases in TP, so it is not expected to significantly increase periphyton biomass in these reaches.

In addition to the effects of changes in nutrient concentrations, periphyton community composition and biomass may be affected by light levels and substrate stability. As discussed for the Hydroelectric Reach (Potential Impact 3.4-4), potential increases in periphyton growth could be counteracted by increased flow variability during storm flow (see also Potential Impact 3.6-3) and by more frequent river sediment movement (Potential Impact 3.11-5). Removal of the Lower Klamath Project dams and reservoirs would produce more flow variations because modeling indicates the Lower Klamath Project dams provide a slight attenuation (1.1 to 6.9 percent) of peak flood flows (USBR 2012) and storm flow variations from tributaries entering the Hydroelectric Reach are dampened by the reservoirs. Additionally, upstream fine and sand sediments currently trapped by the Lower Klamath Project reservoirs would be transported and deposited downstream, so the flow necessary to mobilize the streambed would be less than under existing conditions. Together these processes would potentially increase scour of periphyton during winter and spring storm events following dam removal compared to existing conditions (FERC 2007; North Coast Regional Board 2010, Appendix 2). The magnitude of the effect of bed turnover and scouring on periphyton would decrease with distance downstream, with increased scour occurring from Iron Gate Dam to approximately the Shasta River (RM 179.5). TMDL model results suggest that increased scouring may somewhat limit long-term periphyton biomass following dam removal (North Coast Regional Board 2010, Appendix 2). Overall, these processes would reduce periphyton growth downstream from Iron Gate Dam.

Because of these many competing factors, some that may favor enhanced periphyton growth downstream from Iron Gate Dam (i.e., increasing nutrient transport and recycling), and some that counteract this response (i.e., increasing uptake and retention of nutrients by periphyton in the Hydroelectric Reach, increasing frequency and intensity of scouring events, eliminating seasonal nutrient releases from reservoir sediments), it is likely that long-term increases in periphyton growth in the Middle and Lower Klamath River, should they occur, would not be sufficient to result in an overall increase in the growth, extent, duration, or biomass of nuisance periphyton species, and would therefore be less than significant.

Klamath River Estuary

As discussed for the Middle and Lower Klamath River, periphyton growth in the Klamath River Estuary could be affected by increased nutrient availability following dam removal.

Long-term increases in nutrients in the Klamath River Estuary would be relatively small due to tributary dilution and nutrient retention in the 190 river miles between Iron Gate Dam and the Klamath River Estuary, with the Yurok Tribe analysis modeling reporting a potential increase of approximately 0.15 mg/L or less total nitrogen and approximately 0.01 mg/L or less total phosphorus in the Klamath River Estuary (see Figure 3.2-19; Asarian et al. 2010). The Yurok Tribe analysis' estimate of nutrient increases conservatively includes assumptions that would tend to over-estimate the potential change since it does not consider other possible factors that may decrease nutrients under the Proposed Project, such as full TMDL implementation or elimination of peaking flows from hydropower operations upstream of Copco No. 1 Reservoir. There would be an even smaller long-term increase in nutrients to the Klamath River Estuary, if these other factors occur (Asarian et al. 2010).

Estimated long-term increases in nutrients to the Klamath River Estuary are less than or within current annual and inter-annual variations in nutrients, suggesting the long-term increases in nutrients would not result in an increase in periphyton growth beyond the range occurring under existing conditions. In the Klamath River Estuary between 2010 and 2014, the annual variation between maximum and minimum total nitrogen ranged from 0.28 to 0.55 mg/L, with a 0.13 to 0.18 mg/L variation in peak total nitrogen between years. The annual variation between maximum and minimum total phosphorus ranged from 0.03 to 0.15 mg/L, with a 0.01 to 0.12 mg/L variation in peak total phosphorus between years from 2010 to 2014 (Sinnott 2011b, 2012b; Hanington and Torso 2013; Hanington and Stawasz 2014; Hanington and Cooper-Carouseli 2014). These annual variations are less than the estimated long-term increases in total nitrogen (i.e., 0.15 mg/L or less) and total phosphorus (i.e., 0.01 mg/L or less) and the inter-annual variations in peak nutrient concentrations are within the estimated long-term increases in nutrient concentrations. Variations in the growth of periphyton that rely on nitrogen in the water for growth (i.e., non-nitrogen fixing species like *Cladophora* sp.) would be expected to be within the range of existing conditions since the estimated long-term increase in nitrogen is within the range of total nitrogen variations under existing conditions. Additionally, nitrogen-fixing species that can fix their own nitrogen from the atmosphere dominate the periphyton communities in the lower reaches of the Klamath River where inorganic nitrogen concentrations are low (Asarian et al. 2010, 2014, 2015; Gillet et al. 2016) and these species also likely dominate the periphyton community in the estuary. Increases in total nitrogen due to dam removal are not likely to significantly increase periphyton biomass of these species in the Klamath River Estuary, since additional nitrogen could be obtained from the atmosphere by these periphyton, regardless of nutrient inputs. Some variation in periphyton growth could occur in the Klamath River Estuary due to the long-term increase in phosphorus. However, the estimated long-term increase in phosphorus is on the low end of natural variations in phosphorus in the Klamath River Estuary, so the growth and abundance of periphyton species, including nuisance periphyton species, in the estuary would likely remain within the current annual variation in periphyton growth.

Overall, the biological significance of potential increases in periphyton biomass in the Klamath River Estuary and its influence on designated beneficial uses is unknown due to uncertainty regarding the magnitude of increase in biomass required to generate a significant reduction in habitat quality for aquatic resources (North Coast Regional Board 2010, Appendix 2). Nonetheless, for the reasons described above, under the Proposed Project long-term increases in the growth of nuisance periphyton species in the Klamath

Estuary would be a less-than-significant impact since they would be within the range of existing conditions.

Significance

No significant impact for the Middle and Lower Klamath River and the Klamath River Estuary

3.4.6 References

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3.5 Terrestrial Resources

This section describes existing conditions of terrestrial resources in the Area of Analysis and analyzes potential impacts that the Proposed Project would have on these resources. Terrestrial resources include existing terrestrial vegetation and rare natural communities[108] and their value as habitat for wildlife; terrestrial special-status[109] wildlife and plant species; use and dependence of terrestrial species on riparian, wetland, and aquatic reservoir habitat; and terrestrial wildlife corridors.

A moderate number of comments were received during the NOP public scoping process relating to terrestrial resources (see Appendix A). The majority of commenters stated that the existing reservoirs provide breeding and resting habitats for many wildlife species, and these species should be considered and studied to assess impacts from dam removal. For example, one commenter recommended that the best available science be used to inform dam removal and riparian restoration planning and that robust regional avian science and conservation objectives be integrated into planning and evaluation. Comments associated with aquatic wildlife (e.g., whales and sea lions) are addressed in Section 3.3 *Aquatic Resources*. A summary of the terrestrial resource comments received during the NOP public scoping process, as well as the individual comments themselves, are presented in Appendix A.

3.5.1 Area of Analysis

The Area of Analysis for terrestrial resources (Figure 3.5-1) is the California portion of the Klamath Basin that may be influenced by the Proposed Project and focuses on terrestrial resources downstream from the dams proposed for removal, within the reservoir footprints, and upstream of and surrounding the reservoirs in areas that may be impacted by construction activities.

For this EIR, the Area of Analysis for terrestrial resources is subdivided into two areas, the Primary Area of Analysis and the Secondary Area of Analysis (Figure 3.5-1). The Primary Area of Analysis includes areas associated with proposed dam removal activities and reaches of the Klamath River that have the potential to be affected by dam removal, whereas the Secondary Area of Analysis accounts for potential future actions during the transfer of Parcel B lands to the respective states (i.e., California or Oregon), or to a designated third-party transferee following dam removal (see also Section 2.7.10 *Land Disposition and Transfer*. The analysis for this EIR focuses mainly on the Primary Area of Analysis. For the Secondary Area of Analysis, the EIR briefly reviews potential

[108] Rare natural communities are defined as those natural community types with a state ranking of S1 (critically imperiled), S2 (imperiled), or S3 (vulnerable).

[109] Special-status species are defined as those species listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA); and those designated by the USDA Forest Service as sensitive or watch list species. Additional listings for plants include those listed as rare under the California Native Plant Protection Act and/or included on CDFW's most recent *Special Vascular Plants, Bryophytes, and Lichens List* with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4 (CDFW 2017a). Additional listings for wildlife include those designated as a Species of Special Concern by CDFW; designated as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515); and/or protected under the federal Bald and Golden Eagle Protection Act.

future actions on Parcel B lands following dam removal. However, because of uncertainty regarding what activities, their extent, and their precise location, this analysis is necessarily less detailed.

The Primary Area of Analysis is defined as the Limits of Work plus a 0.25-mile buffer, which includes the Proposed Project construction locations in California (e.g., Proposed Project facilities, staging and disposal areas, recreation locations, transmission lines), the Klamath River reaches from the Oregon-California state line to the Pacific Ocean, and the three California Lower Klamath Project reservoirs (Copco No. 1 Reservoir, Copco No. 2 Reservoir, and Iron Gate Reservoir) (Figure 3.5-1). The 0.25-mile buffer was included to account for terrestrial wildlife species that may occur adjacent to the Limits of Work and may be potentially affected by the Proposed Project activities. For northern spotted owl, the Primary Area of Analysis includes a 0.25-mile, 0.-5 mile, or up to a 1-mile buffer around the Limits of Work to address the potential for noise impacts due to blasting and revegetation activities from helicopters or use of heavy equipment (e.g., disking) as part of the Proposed Project. The northern spotted owl buffer is based on a disturbance distance, which is defined as the distance at which an owl, if present, could be distracted from its normal activity (USFWS 2008). Specifically, the Primary Area of Analysis for the northern spotted owl is a 1-mile buffer around Copco No. 1, Copco No. 2, and Iron Gate dams to account for the loudest noise disturbance distance associated with blasting, a 0.5-mile buffer around the reservoirs to account for the loudest noise disturbance distance associated with helicopter use, and a 0.25-mile buffer around all other areas within the Limits of Work to account for noise disturbance associated with heavy equipment (Figure 3.5-1). The Secondary Area of Analysis includes Parcel B lands (Figure 3.5-1).

Proposed Project activities have the potential to affect terrestrial resources at the following locations (a complete list of Proposed Project activities are provided in Section 2.7 *Proposed Project*):

- Copco No. 1—upgrading haul routes/bridges; establishing a disposal site; and removing four 69-kV transmission lines, recreation structures (i.e., Mallard Cove and Copco Cove), dam, penstocks, spillway gates, decks, piers, powerhouse intake structure, gate houses on right abutment, diversion control structure, powerhouse, switchyard, warehouse, and operator residence (see also Table 2.7-3 and Figure 2.7-2).
- Copco No. 2—upgrading haul routes/bridges; establishing a disposal site (same as Copco No. 1); and removing the 69-kV transmission lines, dam, power penstock intake structure, wooden-stave penstock, spillway, concrete pipe cradles, steel penstock, supports, anchors, powerhouse, and tailrace (see also Table 2.7-4 and Figure 2.7-2).
- Iron Gate—upgrading haul routes/bridges; establishing a disposal site; and removing the dam, unused transmission lines and diversion tunnel control gate and tunnel portals, penstock, fish facilities on dam, powerhouse, switchyard, recreation structures (i.e., Fall Creek recreation, Jenny Creek recreation, Wanaka Springs recreation, Camp Creek recreation, Juniper Point recreation, Mirror Cove recreation, Overlook Point recreation, Long Gulch recreation, Iron Gate Hatchery Public Use Area recreation), and water supply pipes (see also Table 2.7-5 and Figure 2.7-4).
- Improvements to the City of Yreka water supply pipeline.

- Modifications to the Fall Creek and Iron Gate hatcheries.

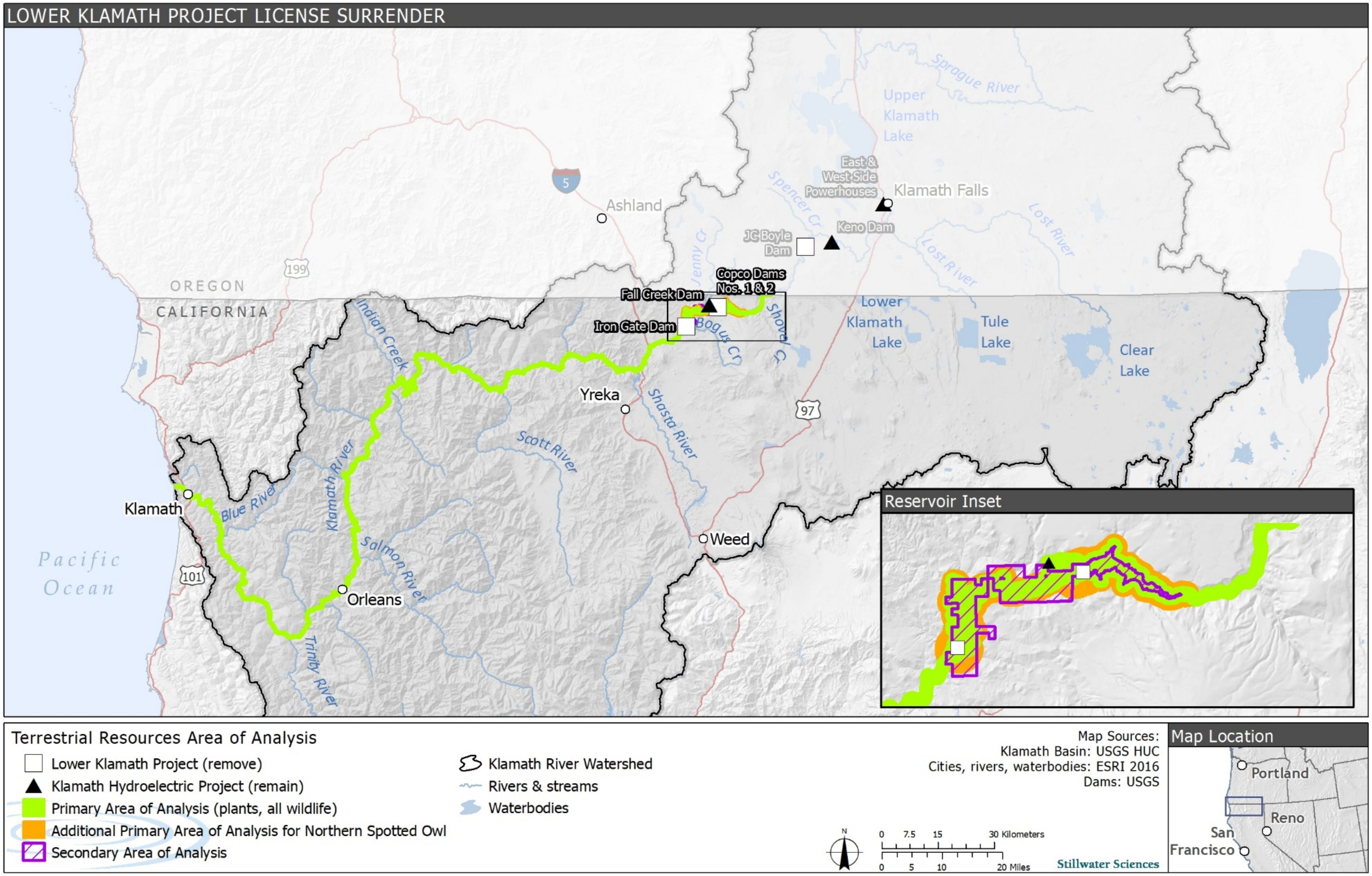

Figure 3.5-1. Area of Analysis for Terrestrial Resources.

3.5.2 Environmental Setting

This section provides a description of the environmental setting for terrestrial resources in the Primary Area of Analysis, including vegetation communities (current and historic), invasive plant species, culturally significant plant species, non-special-status wildlife, and special-status species (plants and wildlife).

The Primary Area of Analysis for terrestrial resources includes diverse habitats ranging from wetland surfaces just below sea level in the Klamath River Estuary (-0.16 ft elevation) to the slopes above the Upper Klamath River near the California-Oregon state line (3,428 ft elevation). The Primary Area of Analysis for terrestrial resources is within the California-Florisic Province and includes the High Cascade Subregion of the Cascade Region and the North Coast, North Coast Ranges, and Klamath Range Subregions of the Northwest Region as defined in The Jepson manual (Baldwin et al. 2012). The High Cascade Subregion is characterized by ponderosa pine (*Pinus ponderosa*), montane fir/pine, and lodgepole pine (*Pinus contorta* subsp. *murrayana*) forests. The North Coast Subregion supports coastal vegetation including coastal prairie, coastal marsh, coastal scrub, closed-cone pine/cypress forest and grand fir (*Abies grandis*)/Sitka spruce (*Picea sitchensis*) forest. The Outer North Coast Ranges District is characterized by very heavy rainfall and supports redwood (*Sequoia sempervirens*), mixed-evergreen and mixed-hardwood forests (Baldwin et al. 2012). The Klamath Range subregion is also characterized by heavy rainfall and is geologically old and serpentine-rich. The Klamath-Siskiyou mountain ranges are recognized for their biological diversity, supporting more than 3,000 plant species including 30 temperate conifer tree species including Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*), ponderosa pine, and sugar pine (*Pinus lambertiana*) (CDFG 2006, Baldwin et al. 2012).

3.5.2.1 Vegetation Communities

Current Vegetation

Information in this section was obtained primarily from the PacifiCorp Final Technical Report on terrestrial resources prepared for the Klamath Hydroelectric Project (PacifiCorp 2004a,b) in combination with the Classification and Assessment with Landsat of Visible Ecological Groupings (CALVEG) datasets available through the California Land Cover Mapping and Monitoring Program (United States Department of Agriculture Forest Service [USDA] Forest Service 2017a) and data from USFWS (2017); additional information was obtained from the CDM Smith's 2018 surveys (CDM Smith 2018a) that covered a portion of the Primary Area of Analysis for terrestrial resources. Table 3.5-1 summarizes the vegetation cover types documented in the Primary Area of Analysis for terrestrial resources based on the California Wildlife Habitat Relationships (CWHR) System (California Department of Wildlife [CDFW] 2014a), and Figures 1 through 66 of Appendix G display the mapped vegetation. Additional habitat types mapped but not included in Table 3.5-1 include a total of 794 acres of agricultural lands (Cropland, Deciduous Orchard, and Pasture), 2,554 acres of developed areas, 1,286 acres of unvegetated habitat (barren, exposed rock and rock talus) and 10,938 acres of aquatic habitat (Riverine, Lacustrine and Marine; USDA Forest Service 2017a). Below is a general description of each CWHR vegetation type within California including specific information regarding the location and acreage of each type within the Primary Area of Analysis. Vegetation types with one acre or less in the Primary Area of Analysis for terrestrial resources are not included in this discussion.

Table 3.5-1. Vegetation Types Documented in the Primary Area of Analysis for Terrestrial Resources.[1]

CHWR Vegetation Cover Types (USDA-FS2017a, USFWS 2017a)	Reaches[2]				Total ac (Percent of total[3])
	Hydroelectric Reach (ac)	Middle Klamath River (ac)	Lower Klamath River (ac)	Klamath River Estuary (ac)	
Upland Habitats					
Annual Grassland (AGS)	1,726	3,405	47	45	**5,223 (9)**
Coastal Oak Woodland (COW)	0	397	1,002	0	**1,398 (3)**
Coastal Scrub (CSC)	0	0	59	32	**91 (<1)**
Douglas-Fir (DFR)	0	10,132	2,769	0	**12,902 (23)**
Jeffrey Pine (JPN)	0	62	0	0	**62 (<1)**
Juniper (JUN)	457	186	0	0	**643 (1)**
Klamath Mixed Conifer (KMC)	9	63	0	0	**72 (<1)**
Mixed Chaparral (MCH)	662	4,031	2	0	**4,694 (9)**
Montane Chaparral (MCP)	0	410	40	0	**450 (1)**
Montane Hardwood (MHW)	1,813	4,996	542	0	**7,350 (13)**
Montane Hardwood-Conifer (MHC)	2,656	8,722	2,500	21	**13,899 (25)**
Perennial Grassland (PGS)	12	238	4	0	**253 (<1)**
Ponderosa Pine (PPN)	68	931	0	0	**998 (2)**
Redwood (RDW)	0	5	905	55	**966 (2)**
Sierran Mixed Conifer (SMC)	1	2,196	0	0	**2,197 (4)**
Wet Habitats					
Estuarine (EST)	0	0	0	398	**398 (1)**
Montane Riparian (MRI)	180	830	894	130	**2,034 (4)**
Palustrine (PAL)[4]	129	508	431	290	**1,357 (2)**
Wet Meadow (WTM)	0	10	3	2	**15 (<1)**
Reach Totals[5]	**7,715**	**37,123**	**9,198**	**972**	**55,009**

1 All vegetation types with a total of one acre or less documented in the Primary Area of Analysis for terrestrial resources are not included in this table.
2 Defined in Figure 2.4-3.
3 Percent of total for vegetation types within the terrestrial resources Primary Area of Analysis; excludes other habitat types (e.g., agricultural lands).
4 Not a CWHR type; based on the Cowardin classification for wetlands and deepwater habits (Cowardin et al. 1979.
5 Totals listed are based on numbers that were not rounded to the nearest acre so may vary slightly from the total derived from adding the acreages per vegetation type as they appear in the table.

Appendix H lists the rare natural communities[110] documented in the Proposed Project vicinity (i.e., the USGS 7.5-minute quadrangles in which the Primary Area of Analysis for terrestrial resources is located and the adjacent quadrangles) in CDFW's California

[110]Rare natural communities are defined as vegetation types with a ranking of S1 (critically imperiled), S2 (imperiled), or S3 (vulnerable) by CDFW.

Natural Diversity Database (CNDDB) (CDFW 2017a) and notes which of those rare natural communities have the potential to be present in the Primary Area of Analysis for terrestrial resources. CDM Smith's 2018 surveys (CDM Smith 2018a) classified vegetation to the alliance level[111] according to the online edition of *A Manual of California Vegetation* (CNPS 2018). Alliances documented during these surveys, including those that are considered rare natural communities, are noted below in the corresponding CWHR type with the exception of the stand of *Hesperocyparis bakeri* Woodland Alliance, a rare natural community, that was documented at Iron Gate Reservoir; it is not included in descriptions below as the corresponding CWHR type (Closed-cone Pine-cypress) has not been documented in the Primary Area of Analysis.

Upland Habitats

Annual Grassland

In California, Annual Grassland occurs throughout the state, mostly on flat plains to gently rolling foothills and on a variety of soil types (CDFW California Interagency Wildlife Task Group 2014a). Annual Grassland accounts for approximately nine percent (5,223 acres) of the Primary Area of Analysis for terrestrial resources and is most prevalent in the Hydroelectric Reach and the Middle Klamath River where it occurs in scattered patches that are most concentrated toward the northern end of the Hydroelectric Reach (Appendix G).

Annual Grassland is dominated by non-native, annual plant species. Common grasses include wild oats (*Avena* spp.), soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus diandrus*), red brome (*Bromus madritensis*), and wild barley (*Hordeum* spp.). Common forbs include filaree (*Erodium* spp.), turkey mullein (*Ereomocarpus setigerus*), true clover (*Trifolium* spp.), bur clover (*Medicago* spp.), and popcorn flower (*Plagiobothrys* spp.) (CDFW California Interagency Wildlife Task Group 2014aCDFW California Interagency Wildlife Task Group 2014a). During 2018 surveys the following alliances (based on the online edition of *A Manual of California Vegetation* [CNPS 2018]) were documented that fall within the Annual Grassland CWHR type: *Bromus tectorum - Taeniatherum caput-medusae* Herbaceous Semi-Natural Alliance (Iron Gate, Copco No. 1, and Copco No. 2 reservoirs); and *Bromus* (*diandrus, hordaceus*) – *Brachypodium distachyon* Herbaceous Semi-Natural Alliance (Copco No. 1 and Copco No. 2 reservoirs; CDM Smith 2018a).

Coastal Oak Woodland

In California, Coastal Oak Woodland occurs in the coastal foothills and valleys from Trinity County to northern Baja California. Soils and parent material are extremely variable (CDFW California Interagency Wildlife Task Group 2014a). Coastal Oak Woodland accounts for approximately three percent (1,398 acres) of the Primary Area of Analysis for terrestrial resources and is most prevalent in the Lower Klamath River toward the eastern end of the reach. There are also a few scattered patches in the Middle Klamath River (Appendix G).

Coastal Oak Woodland is often dominated by Coast live oak (*Quercus agrifolia*). Other overstory species may include: Oregon oak (*Quercus garryana*), California black oak (*Quercus kelloggii*), canyon live oak (*Quercus chrysolepis*), Pacific madrone (*Arbutus menziesii*) and interior live oak (*Quercus wislizeni*); however, where these species

[111] A category of vegetation classification defined in A Manual of California Vegetation (CNPS 2018) describing repeating patterns of plants across a landscape with consistent plant species composition (CNPS 2018).

dominate, the habitat is considered Montane Hardwood. Typical Coastal Oak Woodland understory shrubs include: California blackberry (*Rubus ursinus*), creeping snowberry (*Symphoricarpos mollis*), and toyon (*Heteromeles arbutifolia*). The herbaceous layer includes natives such as western bracken fern (*Pteridium aquilinum*), California polypody (*Polypodium californica*), and miner's lettuce (*Claytonia perfoliata*), as well as a high percentage of non-native, annual grasses (e.g., bromes and oats) (CDFW California Interagency Wildlife Task Group 2014a). During 2018 surveys, the following alliances were documented that fall within the Coastal Oak Woodland CWHR type: *Quercus garryana* (tree) Woodland Alliance (a rare natural community; Iron Gate, Copco No. 1, and Copco No. 2 reservoirs) and *Quercus kelloggii* Forest Alliance (Copco No. 1 and Copco No. 2 reservoirs; CDM Smith 2018a).

<u>Coastal Scrub</u>

Coastal Scrub occurs discontinuously in a narrow band along the Pacific Coast on steep, south-facing slopes and on sandy, mudstone, or shale soils. It usually occurs within 20 miles of the ocean at elevations ranging from sea level to 3,000 feet (CDFW California Interagency Wildlife Task Group 2014a). Coastal Scrub accounts for less than one percent (91 acres) of the Primary Area of Analysis for terrestrial resources and occurs towards the southern end of the Lower Klamath River, and in larger patches closer to the Klamath River Estuary (Appendix G).

In exposed areas very close to the ocean, Coastal Scrub includes yellow bush lupine (*Lupinus arboreus*), which is naturalized to the area (Jepson Herbarium 2017) and many-colored lupine (*Lupinus variicolor*). Farther inland, and in more protected areas, the habitat type is dominated by coyote bush, blue blossom ceanothus, coffeeberry, bush monkey flower (*Mimulus aurantiacus*), blackberry (*Rubus spp.*), poison oak, and salal. Bracken fern, swordfern (*Polystichum californicum*), cow parsnip (*Heracleum lanatum*), several species of Indian paint brush (*Castilleja spp.*), yerba buena *(Satureja douglasii*), and California oatgrass *(Danthonia californica)* are common ground cover species (CDFW California Interagency Wildlife Task Group 2014a).

<u>Douglas Fir</u>

Douglas Fir occurs in the north Coast Range of California, from Sonoma County north to the Oregon border at elevations ranging from 500 to 2,000 feet and in the Klamath Mountains of California and Oregon at elevations from 1,000 to 4,000 feet (CDFW California Interagency Wildlife Task Group 2014a). Relative to the Redwood CWHR habitat type, Douglas Fir occurs on drier sites with poorer soils; soil types include sedimentary granitic and ultramafics (gabbro, peridotite, and serpentine) (CDFW California Interagency Wildlife Task Group 2014a). Douglas Fir accounts for approximately 23 percent (12,902 acres) of the Primary Area of Analysis for terrestrial resources and is most prevalent in the Middle Klamath River; large, dense patches are also concentrated along the Lower and Middle Klamath River reaches (Appendix G). Though it has not been documented, the rare natural community type, Upland Douglas Fir Forest, may be present within the areas classified as Douglas Fir in the Primary Area of Analysis for terrestrial resources (Holland 1986; Appendix H).

The Douglas Fir habitat type is composed of a canopy of at least 50 percent Douglas-fir and a sub-canopy level of broad-leaved evergreen trees. Plant species composition varies with soil parent material, moisture, topography, and disturbance history. Sub-dominant tree species on less rocky, dry soils include canyon live oak, tanoak (*Notholithocarpus densiflorus*), Pacific madrone, and California black oak. A wide range of understory shrubs may be present, varying primarily by soil type and along a moisture gradient, and include the following: Oregon grape (*Berberis aquifolium*), California blackberry, dwarf rose (*Rosa gymnocarpa*), poison oak (*Toxicodendron diversilobum*), vine maple (*Acer circinatum*), California hazel (*Corylus cornuta*), salal (*Gaultheria shallon*), California rhododendron (*Rhododendron macrophyllum*), California laurel (*Umbellularia californica*), California buckthorn (*Rhamnus californica*), and white oak (CDFW California Interagency Wildlife Task Group 2014a).

<u>Jeffrey Pine</u>
Jeffrey Pine occurs in the Klamath Mountains, North Coast Range, Cascade Range, Modoc Plateau, Sierra Nevada, Transverse Range, and the Peninsular Range in California at elevations ranging from 500 to 9,500 feet. Jeffrey Pine habitat is associated with Douglas-fir at its lower elevations and subalpine conifer at its higher elevations in the Klamath Mountains (CDFW California Interagency Wildlife Task Group 2014a). Jeffrey Pine accounts for less than 1 percent (62 acres) of the Primary Area of Analysis for terrestrial resources; a few scattered patches occur in the Middle Klamath River (Appendix G).

Jeffrey Pine habitat is characterized by stands of Jeffrey pine (*Pinus jeffreyi*) as it is the dominant and typically the only species in the canopy layer. Jeffrey pines are generally 98 to 164 feet tall at maturity. Common species include other pines such as ponderosa, Coulter (*Pinus coulteril)*, sugar, and lodgepole pines, as well as red fir (*Abies magnifica*), white fir (*Abies concolor*), incense cedar (*Calocedrus decurrens*), and black cottonwood (*Populus trichocarpa*). The secondary tree layer (i.e., a layer of trees below the canopy layer) is typically composed of aspen (*Populus tremuloides*) on moist sites, California black oak on mesic sites, and pinyon pine (*Pinus monophylla*) and western juniper (*Juniperus occidentalis*) on drier sites. Huckleberry (*Vaccinium spp.),* oak (*Quercus* spp.), manzanita (*Arctostaphylos* spp.), Fremont silktassel (*Garrya fremontii*), and coffeeberry (*Frangula* spp.) dominate the shrub layer (CDFW California Interagency Wildlife Task Group 2014a).

<u>Juniper</u>
In California, Juniper occurs in the Modoc Plateau, portions of the Cascades, higher elevations of the Sierra Nevada, a number of the smaller interior coast ranges, and parts of the Mojave Desert (CNPS 2018), at elevations ranging from 330 to 10,170 feet. Juniper accounts for approximately one percent (643 acres) of the Primary Area of Analysis for terrestrial resources and is most prevalent in the Middle Klamath River, with a few, scattered patches occurring in the Hydroelectric Reach (Appendix G).

Juniper habitat type is characterized by an open to dense overstory of juniper (*Juniperus* spp.) with grass and shrub understories. Junipers are generally 15 to 30 feet tall at maturity. Common species include white fir and Jeffery and ponderosa pines, as well as curl leaf mountain-mahogany (*Cercocarpus ledifolius*), antelope bitterbrush (*Purshia tridentata*), and big sagebrush (*Artemisia tridentata* subsp. *tridentata*) (CDFW California Interagency Wildlife Task Group 2014a, CNPS 2018). During 2018 surveys, *Juniperus occidentalis* Woodland Alliance was documented at Iron Gate Reservoir (CDM Smith 2018a).

<u>Klamath Mixed Conifer</u>
Klamath Mixed Conifer is found in the Klamath Region of northern California and southern Oregon. The region covers a complex of small mountain ranges, including the

Trinity Alps, which are characterized by glacially influenced topography of rugged steep slopes and deeply scoured terrain. Klamath Mixed Conifer is generally found between 4,500 and 6,900 feet (CDFW California Interagency Wildlife Task Group 2014a). Klamath Mixed Conifer accounts for less than one percent (72 acres) of the Primary Area of Analysis for terrestrial resources, with only a few scattered patches in the Middle Klamath River (Appendix G).

Klamath Mixed Conifer generally forms a dense overstory with a mixture of conifers and the occasional broad-leaved species. The understory is often a rich shrub layer, including small individuals of the overstory species, with a well-developed herbaceous layer. The dominant conifer species include white fir, Douglas-fir, ponderosa pine, incense cedar, and sugar pine. Shrub and herbaceous species include Sierra laurel (*Leucothoe davisiae*), Sadler oak (*Quercus sadleriana*), dwarf rose (*Rosa bridgesii*), thimbleberry (*Rubus parviflorus*), twinberry (*Lonicera involucrate*), rattlesnake plantain (*Goodyera oblongifolia*), and prince's pine (*Chimaphila* spp.) (CDFW California Interagency Wildlife Task Group 2014a).

<u>Mixed Chaparral</u>

Mixed Chaparral is an evergreen sclerophyllous shrubland type that occurs in the foothills and mid to upper mountain sides of the coast ranges as well as the Sierra Nevada, at elevations below 5,000 feet (Barbour et al. 2007). Mixed Chaparral can occur on all slope aspects and is most common on north-facing slopes at lower elevations. In these areas, shrubs adapted to dry conditions and soils with low nutrients are able to out-compete trees (CDFW California Interagency Wildlife Task Group 2014a). Mixed Chaparral accounts for approximately nine percent (4,694 acres) of the total acreage of the Primary Area of Analysis for terrestrial resources and is most prevalent in the Middle Klamath River, with dense patches occurring on the northern end of the Middle Klamath River (Appendix G).

Mixed Chaparral forms dense stands on thin soils found on steep, north-facing slopes and varies north-to-south and depending upon precipitation regime, aspect, and soil type. Common shrub species include chamise (*Adenostoma fasciculatum)*, toyon, California yerba-santa (*Eriodictyon californicum*), and silk-tassel (*Garrya* spp.) (CDFW California Interagency Wildlife Task Group 2014a). During 2018 surveys, the following alliances were documented that fall within the Mixed Chaparral CWHR type: *Ceanothus cuneatus* Shrubland Alliance (Iron Gate and Copco Nos. 1 and 2 reservoirs); *Rhus trilobata - Crataegus rivularis - Forestiera pubescens* Shrubland Alliance (a rare natural community; Iron Gate Reservoir); and *Cercocarpus montanus* Shrubland Alliance (Copco No. 1 and Copco No. 2 reservoirs; CDM Smith 2018a).

<u>Montane Chaparral</u>

In California, Montane Chaparral occurs in mountainous areas of mid-to high-elevation (3,000 to 10,000 ft) in the North Coast Ranges, Klamath and Cascades mountains, and in the Transverse Range in the south (CDFW California Interagency Wildlife Task Group 2014a). Montane Chaparral accounts for approximately one percent (450 acres) of the Primary Area of Analysis for terrestrial resources and is most prevalent in the Middle Klamath River in small patches immediately adjacent to the river (Appendix G).

Montane Chaparral, though markedly variable throughout California, is generally characterized by thick, dense stands of chaparral with little to no understory. In disturbed coniferous habitats, chaparral proliferates easily and may exclude other vegetation. Common species include whitethorn ceanothus (*Ceanothus cordulatus*), snowbrush ceanothus (*Ceanothus velutinus*), greenleaf manzanita (*Arctostaphylos patulal)*, pinemat manzanita (*Arctostaphylos nevadensis)*, hoary manzanita (*Arctostaphlos canescens*), and bitter cherry (*Prunus emarginata*). Conifer and oak trees may occur in sparse stands or as scattered individuals within the chaparral type (CDFW California Interagency Wildlife Task Group 2014a).

<u>Montane Hardwood</u>
In California, Montane Hardwood occurs broadly west of the Cascade-Sierra Nevada crest and is often found on steep, rocky, south-facing slopes within the Sierra Nevada (CDFW California Interagency Wildlife Task Group 2014a). Montane Hardwood accounts for approximately 13 percent (7,350 acres) of the Primary Area of Analysis for terrestrial resources. It is most prevalent in the Middle Klamath River where it is most densely clustered towards the northern half (Appendix G).

Montane Hardwood forms a dense forest with a thick layer of leaf litter and sparse cover of herbaceous species. The dominant species in the tree canopy is canyon live oak except at higher elevations where it is replaced by huckleberry oak (*Quercus vacciniifolia)*. In the North Coast Range, species vary by elevation and may include Douglas-fir, tanoak, Pacific madrone, California laurel, California black oak, knobcone pine (*Pinus attenuata*), foothill pine, coast live oak, California white fir, and Jeffrey pine. Understory vegetation includes manzanita, mountain mahogany, poison oak, and a few forbs (CDFW California Interagency Wildlife Task Group 2014a).

<u>Montane Hardwood-Conifer</u>
In California, Montane Hardwood-Conifer occurs broadly and covers a continuous band along the Sierra Nevada (CDFW California Interagency Wildlife Task Group 2014a). Montane Hardwood-Conifer is the most common habitat type in the Primary Area of Analysis for terrestrial resources, accounting for approximately 25 percent (13,899 acres) of the Primary Area of Analysis, and is most prevalent in the Lower and Middle Klamath River (Appendix G).

Like Montane Hardwood, Montane Hardwood-Conifer forms a dense forest with a thick layer of leaf litter and sparse cover of herbaceous species. Dominant species in the tree canopy include tanoak and California black oak. Common species include ponderosa pine, Douglas-fir, incense-cedar, California black oak, tanoak, Pacific madrone, and Oregon white oak (CDFW California Interagency Wildlife Task Group 2014a). Within the Primary Area of Analysis for terrestrial resources, juniper is also an associate.

<u>Perennial Grassland</u>
Perennial Grassland occurs along the California coast from Monterey County northward and as relic stands within annual grassland habitat patches, generally below 3,280 feet (CDFW California Interagency Wildlife Task Group 2014a). Perennial Grassland accounts for less than one percent (253 acres) of the Primary Area of Analysis for terrestrial resources, and is most prevalent in the Middle Klamath River (Appendix G).

Perennial Grassland is dominated by perennial grass species such as California oatgrass and needlegrass species (*Stipa* spp.). Common species include a variety of native and non-native grasses and forbs including redtop (*Agrostis stolonifera*), soft chess, orchardgrass (*Dactylis glomerata*), Idaho fescue (*Festuca idahoensis*), Douglas iris (*Iris douglasiana*), and western bracken fern (CDFW California Interagency Wildlife

Task Group 2014a). During 2018 surveys, *Festuca idahoensis* Herbaceous Alliance was documented at Copco No. 1 and Copco No. 2 reservoirs (CDM Smith 2018a).

Ponderosa Pine

In California, Ponderosa Pine occurs broadly and covers extensive areas within the Sierra Nevada at elevations between 800 and 5,000 feet (CDFW California Interagency Wildlife Task Group 2014a). Ponderosa Pine accounts for approximately two percent (998 acres) of the Primary Area of Analysis for terrestrial resources, with several scattered patches in the northern half of the Middle Klamath River (Appendix G).

Ponderosa Pine forms an open forest of relatively small-diameter trees. Associated species vary depending on location and site conditions and may include white fir, incense-cedar, Jeffrey pine, sugar pine, Douglas-fir, canyon live oak, California black oak, Oregon white oak, Pacific madrone, tanoak, manzanita, ceanothus, and poison oak (CDFW California Interagency Wildlife Task Group 2014a). During 2018 surveys, *Pinus ponderosa* Forest Alliance was documented at Copco No. 1 and Copco No. 2 reservoirs (CDM Smith 2018a).

Redwood

Redwood habitat is generally present within two to 10 miles of the coast (CDFW California Interagency Wildlife Task Group 2014a) in areas of consistent fog, high summer humidity, cool temperatures, and well-developed soils (Shuford and Timossi 1989) and can be found in elevations ranging from sea level to 3,000 feet (CDFW California Interagency Wildlife Task Group 2014a). Forests of pure coast redwood transition to redwood/Douglas-fir forests farther inland (CDFW California Interagency Wildlife Task Group 2014a) along a gradient of increased evapotranspiration and inadequate soil moisture (Mahony and Stuart 2000, Van Wagtendonk et al. 2018). Coast redwood trees tend to taper out approximately 31 miles inland from the coast (CDFW California Interagency Wildlife Task Group 2014a). Redwood accounts for approximately two percent (966 acres) of the Primary Area of Analysis for terrestrial resources and is most prevalent in the Lower Klamath River, with dense patches closer to the coast and clustered patches in the center of the reach (Appendix G).

Redwood and Douglas-fir trees often co-occur in areas classified as the Redwood habitat type, with Douglas-fir occupying up to half of the canopy cover. The associated species mix varies both north-to-south, as well as inland from the coast. Common associated tree species include Douglas-fir, tanoak, and Pacific madrone, with the following species potentially contributing: Bishop pine, grand fir, golden chinquapin (*Chrysolepis chrysophylla*), western hemlock, red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), California laurel, and nutmeg (*Torreya californica*). Shrub species include blue blossom (*Ceanothus thyrsiflora*), coyote brush (*Baccharis pilularis*), manzanita, and California huckleberry (CDFW California Interagency Wildlife Task Group 2014a).

Sierran Mixed Conifer

In California, Sierran Mixed Conifer dominates the middle elevations of the western slope of the northern Sierra Nevada, at elevations ranging from 2,500 to 4,000 feet (CDFW California Interagency Wildlife Task Group 2014a). Sierran Mixed Conifer accounts for approximately four percent (2,197 acres) of the Primary Area of Analysis for terrestrial resources and is concentrated in dense patches towards the northern end of the Middle Klamath River (Appendix G).

Sierran Mixed Conifer forms a dense forest, with tree crowns often touching. Various conifers co-dominate, including white fir, Douglas-fir, ponderosa pine, sugar pine, and incense-cedar; California black oak is also present. Common understory species include ceanothus, manzanita, tanoak, bitter cherry, mountain whitethorn, gooseberry (*Ribes* spp.), and rose (*Rosa* spp.) (CDFW California Interagency Wildlife Task Group 2014a).

Wet Habitats

Estuarine

Estuarine habitat occurs along coastal California at the mouth of perennial rivers (CDFW California Interagency Wildlife Task Group 2014a). Estuarine habitat accounts for approximately one percent (398 acres) of the Primary Area of Analysis for terrestrial resources and is located in the Klamath River Estuary (Appendix G).

Estuarine habitat includes areas that are periodically or permanently inundated, including open water portions of semi-enclosed coastal waters where tidal seawater is diluted by freshwater. California estuaries do not often conform to the classic description of an estuary due to a restricted coastal plain and stream flow regimes characterized by summer drought. Estuarine habitat contains a high density of a few species that are able to withstand an estuary’s many physiological stressors, such as varying salinity. Suspended organisms, such as phytoplankton, occur in the open water of estuaries and are densest near the surface and in low-salinity areas in summer. Other associated species include algae (green and red) and eelgrass (*Zostera* spp.), which grow in dense stands in many subtidal estuarine habitats (CDFW California Interagency Wildlife Task Group 2014a).

Montane Riparian

Montane Riparian forest occurs in narrow bands along streams below 8,000 feet (CDFW California Interagency Wildlife Task Group 2014a). Montane Riparian habitat accounts for approximately four percent (2,034 acres) of the Primary Area of Analysis for terrestrial resources. It occurs along the river and reservoir shorelines in scattered patches throughout the Primary Area of Analysis for terrestrial resources but is most prevalent in the Lower and Middle Klamath River. A portion of the Middle Klamath River, from Iron Gate Dam to the Shasta River confluence, contains the highest percentage (approximately 41 percent) of Montane Riparian habitat in the Primary Area of Analysis for terrestrial resources (Appendix G).

Within the Klamath Range, Montane Riparian tends to be dominated by black cottonwood (*Populus balsamifera* subsp. *trichocarpa*) and may be codominant with bigleaf maple; dogwood (*Cornus* spp.), and boxelder (*Acer negundo*) are also present. At high elevations, quaking aspen and white alder (*Alnus rhombifolia*) may also be present. Oregon ash (*Fraxinus latifolia*), willow, and a high diversity of forbs are common associates (CDFW California Interagency Wildlife Task Group 2014a). Within the Primary Area of Analysis for terrestrial resources, the species composition of Montane Riparian varies by reach and includes the following subcategories as defined in PacifiCorp (2004a, b):

- riparian grassland: characterized by a dense herbaceous cover;
- riparian scrub: dominated by coyote willow and arroyo willow with Oregon ash saplings prevalent;

- riparian deciduous: characterized by a moderate canopy cover including coyote willow and shining willow and/or alder (white or red, depending on location), with moderate shrub and herb layers; and
- riparian mixed deciduous-coniferous: characterized by a dense tree layer that includes both deciduous riparian tree species and upland conifer tree species, moderate density shrub layer, and open herbaceous layer that includes reed canarygrass and devil's beggarstick (*Bidens frondosa*).

In the Lower Klamath River and Klamath River Estuary, red alder is dominant. The Middle Klamath River is typically populated with coyote willow, shining willow, Oregon ash, and Oregon oak. In the Hydroelectric Reach along the Copco No. 2 Bypass Reach, white alder is dominant and dense enough to prohibit establishment of coyote willow and reed canarygrass (PacifiCorp 2004a,b). During 2018 surveys, the following alliances were documented that fall within Montane Riparian CWHR type: *Fraxinus latifolia* Forest Alliance (Iron Gate, Copco No. 1, and Copco No. 2 reservoirs) and *Acer macrophyllum* Forest Alliance (Copco No. 1 and Copco No. 2 reservoirs; CDM Smith 2018a). These are both rare natural community types.

<u>Palustrine</u>
Palustrine is a habitat type defined in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979) that includes all non-tidal wetlands as well as wetlands in tidal areas where ocean-derived salinity is below 0.5 percent. They are by definition less than 20 acres in size, lack active wave-formed or bedrock shoreline features, and are less than 6 feet deep at low water. Palustrine habitat occurs throughout California on the perimeters of lakes, river channels, and estuaries, as well as in river floodplains, isolated catchments, and depressions on slopes. Palustrine habitat accounts for approximately two percent (1,357 acres) of the Primary Area of Analysis for terrestrial resources. It occurs to varying degrees along the Lower Klamath Project reservoirs and river reaches, primarily limited to small patches in protected locations and near reservoir inlets and tributary mouths. Palustrine habitat occurs throughout the Lower and Middle Klamath River reaches and is most densely clustered in the Klamath River Estuary and the northern end of the Middle Klamath River (Appendix G).

Palustrine habitat can be broken into the following categories: Palustrine Emergent Wetland, Palustrine Scrub-shrub Wetland, Palustrine Forested Wetland, and Palustrine Aquatic Bed. Palustrine Emergent Wetland is dominated by a dense herbaceous layer, commonly including cattails (*Typha* spp.), bulrushes, sedges, reed (*Phragmites australis*), manna grasses (*Glyceria* spp.), purple loosestrife (*Lythrum salicaria*), dock (*Rumex* spp.), and many species of smartweeds (*Polygonum* spp.) (Cowardin et al. 1979). Within the Primary Area of Analysis for terrestrial resources, emergent vegetation along the reservoirs includes sedge, rush, bentgrass, bulrush, and cattail. Palustrine Scrub-shrub Wetland is characterized by an open canopy with a moderate shrub layer. Within the Primary Area of Analysis for terrestrial resources, species such as coyote willow (*Salix exigua*) and arroyo willow (*Salix lasiolepis*) are prevalent and coyote willow dominates at the reservoirs. Palustrine Forested Wetland is characterized by a dense tree cover that includes hydrophilic tree species such as coyote willow and shining willow (*Salix lasiandra*), brown dogwood (*Cornus glabrata*), and arroyo willow. Finally, Palustrine Aquatic Bed is dominated by pondweeds (*Potamogeton* spp.) and coontail (*Ceratophyllum demersum*) (PacifiCorp 2004a,b). During 2018 surveys, the following alliances were documented that fall within the Palustrine habitat type: *Typha (angustifolia, domingensis, latifolia)* Herbaceous Alliance (Iron Gate Reservoir); *Salix exigua* Shrubland Alliance (Iron Gate Reservoir); and *Schoenoplectus acutus* Herbaceous Alliance (Iron Gate, Copco No. 1, and Copco No. 2 reservoirs; CDM Smith 2018a).

Wet Meadow

Wet Meadow occurs along streams, areas with concave topography, and/or where springs or seeps provide abundant available water (Ratliff 1985). The habitat type usually occurs above 3,940 feet in the north of the Tahoe Basin and above 5,900 feet to the south of the Basin (CDFW California Interagency Wildlife Task Group 2014a). Wet meadows account for less than one percent (15 acres) of the Primary Area of Analysis for terrestrial resources, with the highest concentration (10 acres) in the Middle Klamath River (Appendix G).

The Wet Meadow habitat type is characteristically defined by its hydrology: seasonality and reliability of yearly water inflows and outflows largely determine the stability of this habitat type. It tends to succeed bog communities and in turn is succeeded by mesic meadows and dry meadows or forests. The Wet Meadow habitat type is variable throughout California, but generally supports graminoids, including a variety of sedges (e.g., Nebraska sedge [*Carex nebrascensis*] and beaked sedge [*Carex utriculata*]), reed grasses (*Calamagrostis* spp.) and bent grass (*Agrostis* spp.), and a variety of rushes (*Juncus* spp.), and a lower percentage cover of forbs such as Anderson aster (*Aster alpigenus*), primrose monkey flower (*Mimulus primuloides*), cow's clover (*Trifolium wormskioldii*), and small white violet (*Viola macloskeyi*). Shrub cover is present along the margins (CDFW California Interagency Wildlife Task Group 2014a). During 2018 surveys, *Poa pratensis* Herbaceous Semi-Natural Alliance was documented at Copco No. 1 and Copco No. 2 reservoirs (CDM Smith 2018a).

Historical Vegetation

The area where Copco No. 1 and Copco No. 2 reservoirs are currently located historically consisted of a wide floodplain confined by steep slopes and the distribution of Montane Riparian and Palustrine habitats were situated along several river bends (Figure 3.5-2); there were a total of 66.2 acres of Montane Riparian and 23.7 acres of Palustrine habitat (Table 3.5-2; EDAW 2000). Wet habitats were more limited at Iron Gate Reservoir and was confined to long, thin bands running along the Klamath River channel (Figure 3.5-3); there were 30.1 acres of Montane Riparian and 2.6 acres of Palustrine habitat (Table 3.5-2; EDAW 2000).

When the reservoirs were built, topography limited the establishment of Montane Riparian habitat but in many places the creation of the reservoir created a flat bench that facilitated Palustrine habitat establishment (PacifiCorp 2004a). Currently, there are 11.1 acres of Montane Riparian and 25.2 acres of Palustrine habitat within 300 feet of the reservoir footprint of Copco No. 1 and Copco No. 2 reservoirs and 4.7 acres of Montane Riparian and 27.1 acres of Palustrine habitat within 300 feet of the reservoir footprint of Iron Gate Reservoir (Table 3.5-2; Figures 3.5-4 and 3.5-5; PacifiCorp 2005).

Table 3.5-2. Comparison of Historical (EDAW 2000) and Current (PacifiCorp 2005) Wet Habitat Types at Copco Nos. 1 and 2 and Iron Gate Reservoirs.

CHWR Vegetation Cover Types	Copco Nos. 1 and 2 (ac)	Iron Gate Reservoir (ac)	Total ac
Historical (reservoir footprint) [1]			
Montane Riparian (MRI)	66.2	30.1	**96.3**
Palustrine (PAL)[2]	23.7	2.6	**26.3**
Current (within 300 feet of the reservoir footprint)			
Montane Riparian (MRI)	11.1	4.7	**15.8**
Palustrine (PAL)[2]	25.2	27.1	**52.3**

[1] No historical data is available outside of the reservoir footprint.
[2] Not a CWHR type; based on the Cowardin classification for wetlands and deepwater habits (Cowardin et al. 1979.

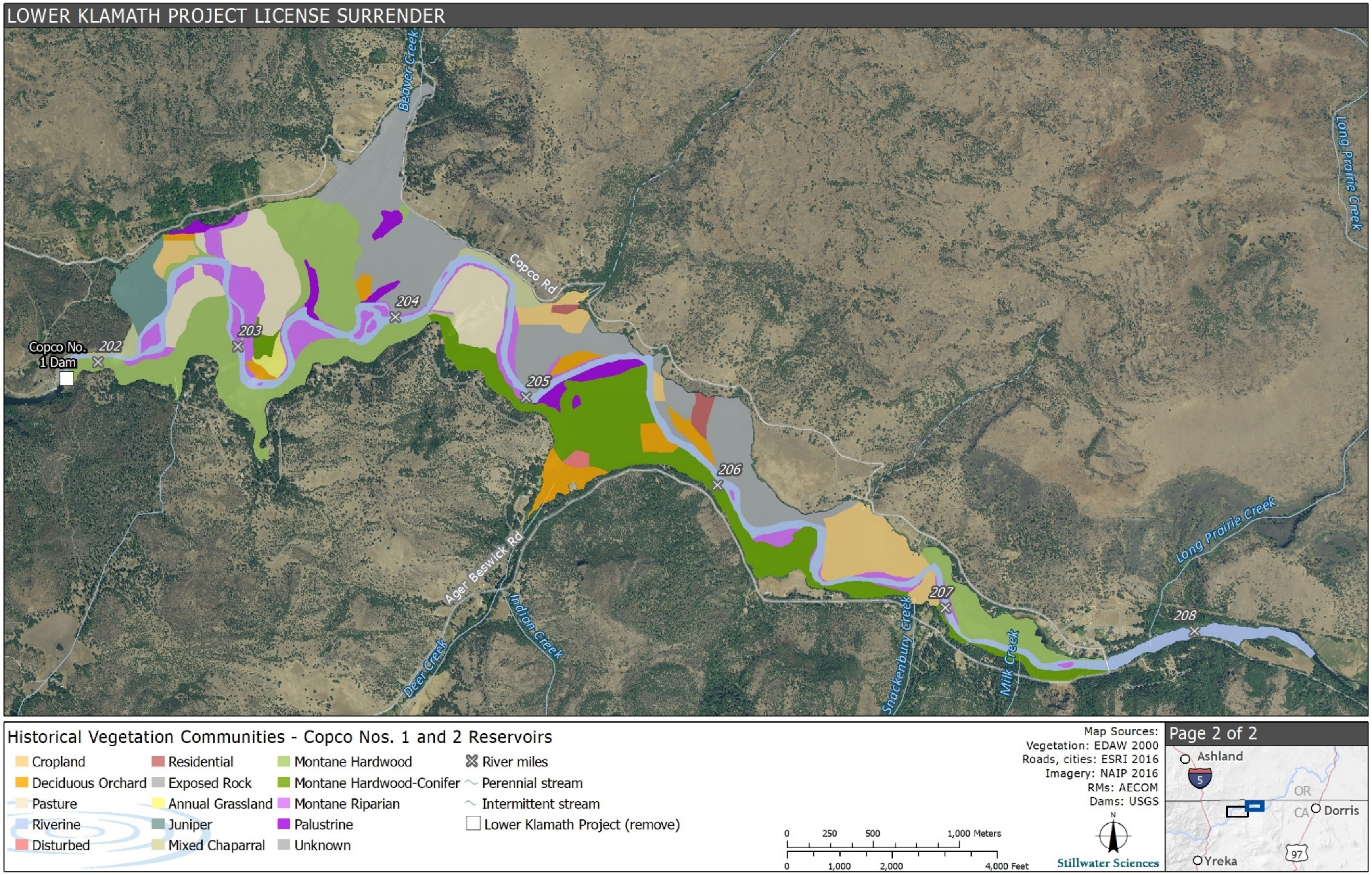

Figure 3.5-2. Historical Vegetation Types in Copco No. 1 and Copco No. 2 Reservoirs.

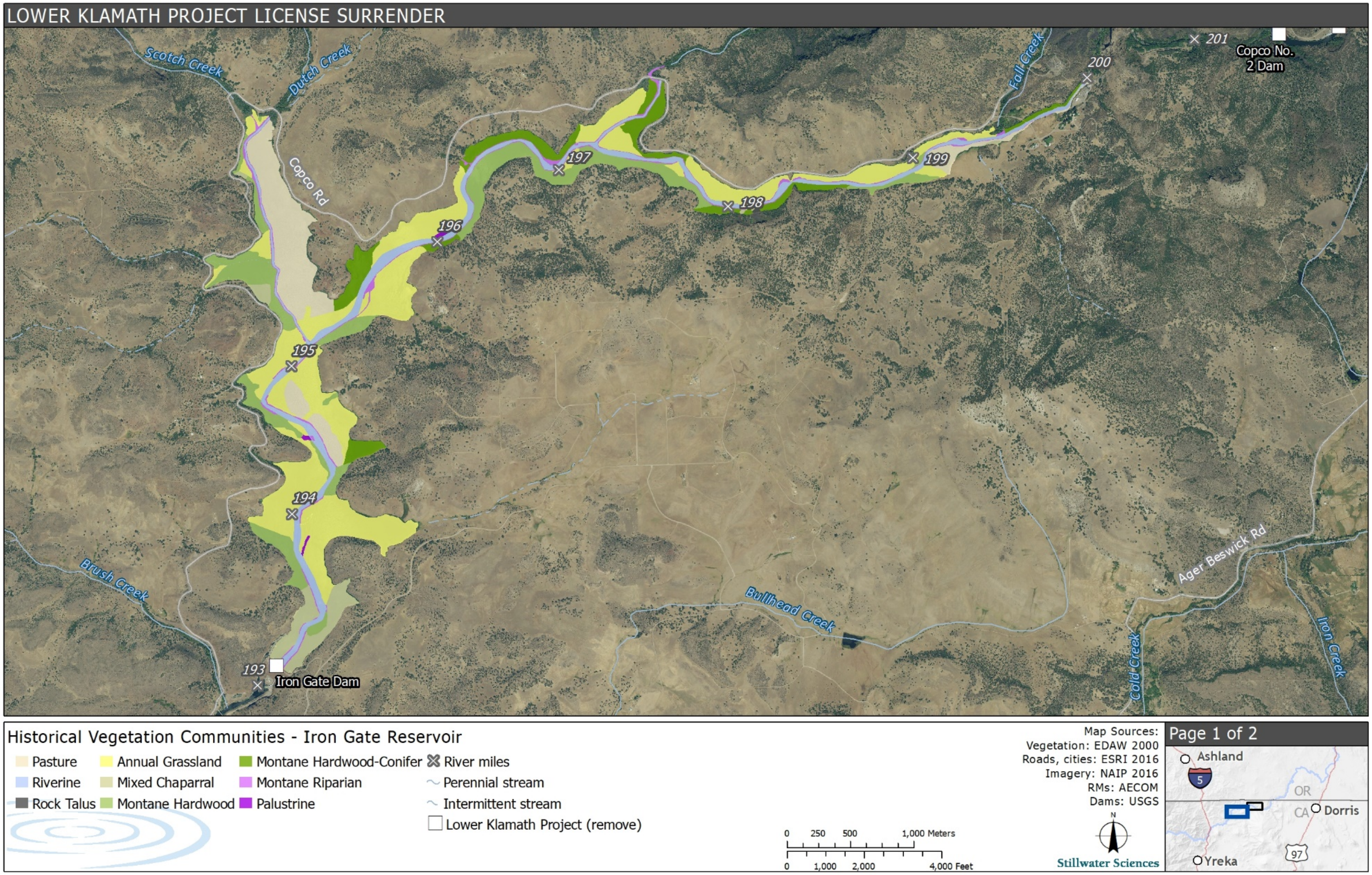

Figure 3.5-3. Historical Vegetation Types in Iron Gate Reservoir.

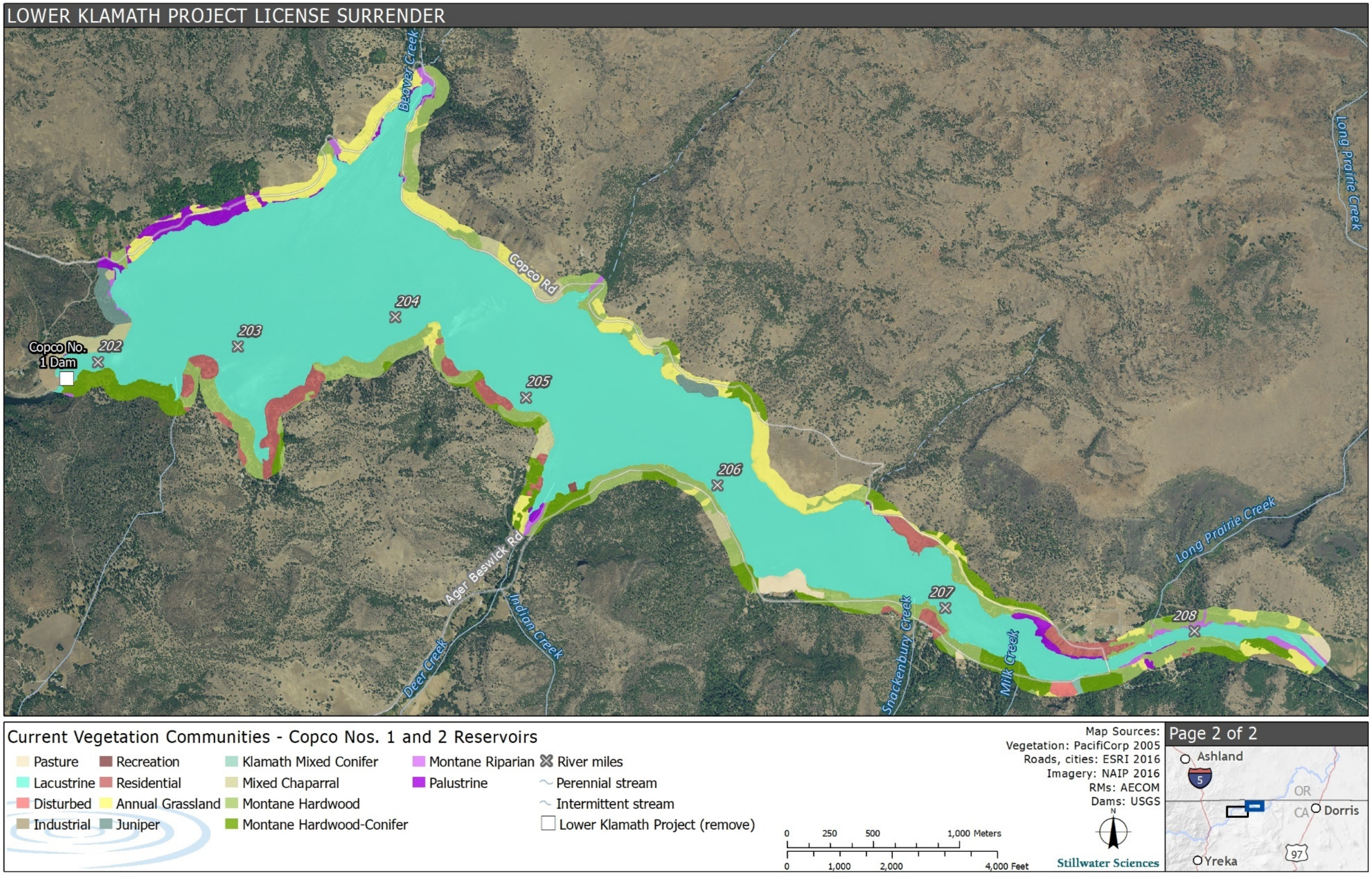

Figure 3.5-4. Current Vegetation Types within a 300-foot Buffer of Copco No. 1 and Copco No.2 Reservoirs.

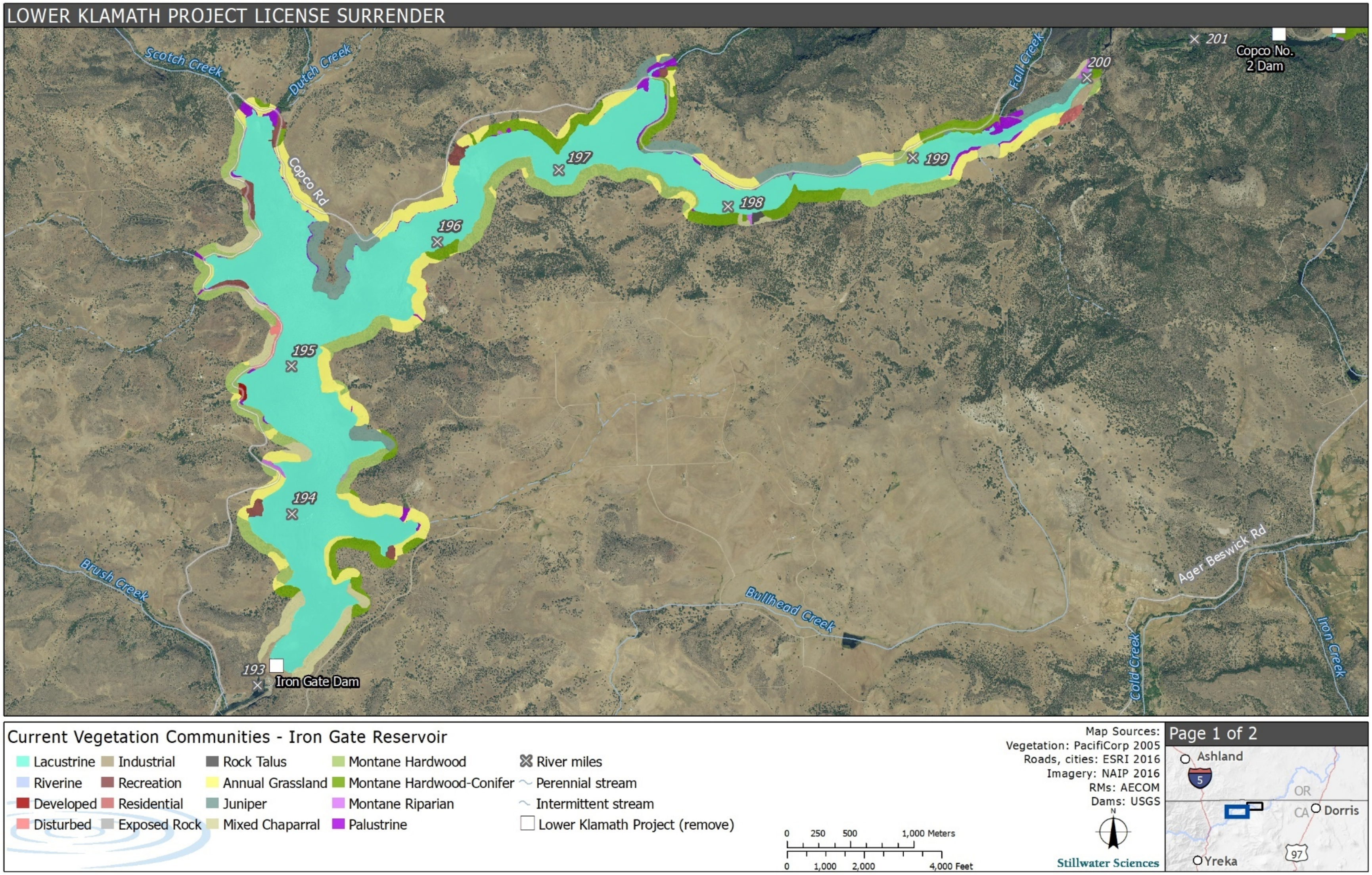

Figure 3.5-5. Current Vegetation Types within a 300-foot Buffer of Iron Gate Reservoir.

3.5.2.2 Invasive Plant Species

Multiple surveys for invasive plant species have been conducted in the Primary Area of Analysis for terrestrial resources. PacifiCorp conducted biological surveys in 2002, 2003, and 2004 (PacifiCorp 2004a,b) in the vicinity of the Primary Area of Analysis (PacifiCorp's study area overlaps but is not an exact match to the Primary Area of Analysis for terrestrial resources); vegetation surveys were conducted around the perimeter of Copco No. 1 and Iron Gate reservoirs in November 2009 and July 2010 (USBR 2011); and reconnaissance surveys were conducted in 2017 within the proposed Limits of Work and areas surrounding the reservoirs (Appendix B: *Definite Plan - Appendix J*). Twenty-two species of invasive plants have been documented within the vicinity of Primary Area of Analysis for terrestrial resources; based on available data, nine of the twenty-two species have been documented within the Primary Area of Analysis for terrestrial resources (Table 3.5-3).

Table 3.5-3. Invasive Plants Documented Within and in the Vicinity of the Primary Area of Analysis for Terrestrial Resources.

Scientific Name	Common Name	Data Source
Acroptilon repens	Russian knapweed	PacifiCorp (2004a,b)
Bromus tectorum	cheat grass	PacifiCorp (2004a,b)
Centaurea diffusa	diffuse knapweed	PacifiCorp (2004a,b)
Centaurea solstitialis[1]	yellow starthistle	PacifiCorp (2004a,b); USBR (2011); Bureau of Land Management (BLM) (2002); Appendix B: *Definite Plan – Appendix J*
Cirsium arvense	Canada thistle	PacifiCorp (2004a,b)
Cirsium vulgare	bull thistle	PacifiCorp (2004a,b)
Conium maculatum[1]	poison hemlock	Larson (2011); BLM (2002)
Cytisus scoparius	Scotch broom	PacifiCorp (2004a,b)
Elymus caput-medusae[1]	Medusahead	PacifiCorp (2004a,b); USBR (2011); Appendix B: *Definite Plan – Appendix J*
Fallopia japonica	Japanese knotweed	Hamilton (2011)
Hypericum perforatum[1]	St. John's wort	PacifiCorp (2004a,b); BLM (2002)
Isatis tinctoria[1]	Dyer's woad	PacifiCorp (2004a,b); EDAW (2004)
Lepidium draba[1]	hoary cress	PacifiCorp (2004a,b); EDAW (2004)
Lepidium latifolium	perennial pepperweed	PacifiCorp (2004a,b)
Linaria dalmatica subsp. *dalmatica*	Dalmatian toadflax	PacifiCorp (2004a,b)
Onopordum acanthium subsp. *acanthium*	Scotch thistle	PacifiCorp (2004a,b)
Persicaria wallichii	Himalayan knotweed	Hamilton (2011)
Phalaris canariensis	reed canary grass	Hamilton (2011)
Rubus armeniacus[1]	Himalayan blackberry	Hamilton (2011); BLM (2002); Appendix B: *Definite Plan – Appendix J*
Salvia aethiopis	Mediterranean sage	PacifiCorp (2004a,b)
Tribulus terrestris[1]	puncture vine	PacifiCorp (2004a,b); BLM (2002); EDAW (2004)
Xanthium spinosum[1]	spiny cocklebur	PacifiCorp (2004a,b); EDAW (2004)

[1] Species documented within the Primary Area of Analysis.

During the PacifiCorp biological surveys conducted in 2002, 2003, and 2004 (PacifiCorp 2004a,b), cheat grass (*Bromus tectorum*), yellow starthistle (*Centaurea solstitialis*), and medusahead (*Elymus caput-medusae*) were the most widespread invasive plants within the study area, and bull thistle (*Cirsium vulgare*) and Canada thistle (*Cirsium arvense*) were also pervasive (PacifiCorp 2004a,b). Many of the surveyed invasive plant species were found in uplands or near the riparian/upland interface and were abundant in areas where ground disturbance was evident (e.g., maintenance areas associated with power plants, transmission lines, flowlines, recreation sites, and roads). Along the Klamath River in high flow reaches, reed canarygrass was a commonly observed riparian plant species (PacifiCorp 2004a).

3.5.2.3 Culturally Significant Plant Species

Many plants in the Primary Area of Analysis for terrestrial resources were used by Native American Tribes in the Klamath River region as food sources (see also Section 3.12.2.1 *Cultural Chronology and Ethnography*); examples include seeds of wocus (yellow pond lily, *Nuphar lutea* subsp*olysepala*) and rootstocks of broad-leaved cattail (*Typha latifolia*) and bur reed (*Sparganium emersum*). Other plants such as hardstem bulrush (*Schoenoplectus acutus* var. *occidentalis*), cattails, and willows (*Salix* spp.) were used for basketry, clothing, and shelter (Larson and Brush 2010). Many of these plants are still culturally important today. Culturally significant plants used for food sources by the Yurok Tribe include acorns, seaweed, salal, wild grape (*Vitis californica*), various roots and berries including salmonberry (*Rubus spectabilis*), huckleberry and gooseberry and currants (O'Rourke 2017, 2016). Culturally significant plants used for food sources by the Shasta people include buckeye (*Aesculus californica*), pine nuts, manzanita berries, and a variety of other plants; acorns were a staple of the Shasta people's diet (Dixon 1907, Silver 1978).

Culturally significant plants used for basketry by the Yurok and/or Karuk tribes include alder (*Alnus* spp.), bear grass (*Xerophyllum tenax*), black maidenhair fern (*Adiantum capillus-veneris*), chain fern (*Woodwardia fimbriata*), chitum bark (*Frangula purshiana*), cottonwood (*Populus* spp.), hazel sticks (*Corylus cornuta*), mosses, sugar pine , redwood, spruce (*Picea* spp.), tobacco (*Nicotiana*), wild grape, Oregon grape and willow sticks and roots (O'Rourke 2017, 2016 and Hillman 2017, 2016) Many of these same plants are important medicinal plants used in healing and ceremony (Yurok Tribe Environmental Program 2009).

Culturally significant plants used as materials for fabrics and utensils by the Yurok include tanoak acorns, hazelnuts, pepperwood nuts (*Umbelleria californica*), berries, grasses, and bushes. Tall redwood trees are considered culturally significant by the Yurok as they used as part of the constitution and blessing and for the construction of canoes. Finally, culturally significant plants used as trade items by the Yurok include sugar pine nuts, tobacco seed, and juniper beads (O'Rourke 2017, 2016).

3.5.2.4 Non-special-status Wildlife

Information regarding non-special-status wildlife was compiled from surveys conducted by KRRC in 2018 and PacifiCorp in 2002 and 2003. The 2018 general wildlife surveys consisted of walking-transect surveys within a buffer of 0.25 mile of the proposed Limits of Work and via a boat along reservoir shorelines and open water (Appendix B: *Definite Plan*). The 2018 surveys focused on special-status species; however, some California non-special-status species of birds were also documented. PacifiCorp conducted terrestrial wildlife surveys in a variety of habitats in 2002 and 2003 and detected (or documented from other sources, such as BLM surveys from 2000 and 2001) numerous wildlife species (PacifiCorp 2004a). Targeted species surveys were conducted within areas that supported aquatic, wetland, and riparian habitats for amphibian breeding and refuge; upland and aquatic habitats for reptiles (e.g., snakes and turtles), and habitats for birds such as talus and mixed riparian habitats, sagebrush, aquatic, wetlands, pastures, and buildings. PacifiCorp also monitored mammal habitat surrounding Project facilities using track surveys, photographic bait stations, and structure monitoring for bat use. Incidental observations of species were also documented. Although the 2002 and 2003 PacifiCorp surveys are more than 15 years old, the wildlife previously documented have a reasonable potential of occurring in California under existing conditions as habitat conditions have not substantively changed since the surveys were conducted (e.g., reservoirs are still present).

Below is a summary of the numerous non-special status amphibians, reptiles, birds, and mammals documented, in or near the Primary Area of Analysis for terrestrial resources in California by KRRC, PacifiCorp, and BLM (PacifiCorp 2004a, CDM Smith 2018c). Species documented only in the J.C. Boyle Peaking Reach (by PacifiCorp or BLM) are noted in parenthesis when it was not clear if the species was observed in California or Oregon. Regardless, due to the proximity of the J.C. Boyle Peaking Reach to the state line, it is reasonable to assume that these species have the potential to occur in California.

- Non-special-status amphibians–Pacific giant salamander, western toad, Pacific treefrog, and non-native bullfrog;
- Non-special-status reptiles—southern alligator lizard, western fence lizard, striped whipsnake, California mountain kingsnake, California kingsnake, gopher snake, common kingsnake, common garter snake, and western rattlesnake (species documented only in J.C. Boyle Peaking Reach included western yellow-bellied racer, western terrestrial garter snake, ringneck snake, rubber boa, western skink);
- Non-special-status-birds—mountain quail, double-crested cormorant, herons (great blue, black-crowned night), great egret, bufflehead, osprey, hawks (sharp-shinned, Cooper's), great-horned owl, terns (Forster's, Caspian), woodpeckers (acorn, pileated, Lewis'), black phoebe, black-capped chickadee, pygmy nuthatch, blue-gray gnatcatcher, western bluebird, and Swainson's thrush, (species documented only in J.C. Boyle Peaking Reach include, prairie falcon, flammulated owl, and merlin). Surveys conducted by KRRC in May 2018 also documented several osprey nests on platforms located on top of electrical poles in the Iron Gate Reservoir area (CDM Smith 2018c); and
- Non-special-status mammals—western harvest mouse, montane vole, woodrat (dusky-footed, bushy-tailed), squirrel (western gray, California ground), black-tailed deer, elk, bobcat, beaver, mink, river otter, mountain lion, and Yuma myotis (bat).

Surrounding areas also support habitat for wild horse herds, bighorn sheep, and habitat components critical for deer to winter in the area. CDFW has identified areas north and south of Iron Gate Reservoir, Copco No. 2 Reservoir, Copco No. 1 Reservoir, and the Klamath River upstream to the Oregon-California state line as critical deer wintering habitat (CDFW 2014a). CDFW identifies wintering range to include habitat elements important to the survival of deer in the winter, which may include corridors essential for movement, staging areas where deer temporarily congregate, and high-quality winter forage (CDFW 2014a). This area represents one of the largest contiguous areas of deer winter range in the southern Oregon and northern California region. BLM's Pokegama Wild Horse Herd Management Area lies primarily in Oregon, but also includes portions in California north of the Klamath River. PacifiCorp reported that the wild horse herd roams throughout the area, from locations near Fall Creek to near J.C. Boyle Dam (PacifiCorp 2004a). Wild horse herds have also been documented along the western shore of Iron Gate Dam and based on data provided by CDFW in 2017, bighorn sheep are located along the north side of Copco No. 1 Reservoir and northeast of the confluence of Shovel Creek and the Klamath River (Figure 3.5-6).

Wildlife such as egrets, herons, raptors, river otters, and bears may forage on natural-origin or Iron Gate Hatchery-produced out-migrating salmonids (coho, fall-run Chinook, and steelhead) and adult returns (see Section 3.3.2.1 *Aquatic Species*). CDFW operates Iron Gate Hatchery, with an annual production goal of 75,000 coho salmon smolts, 6 million fall-run Chinook salmon yearlings and smolts, and 200,000 steelhead smolts (CDFW 2014b, detailed in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*). However, the ability to meet the production goals varies annually based on adult returns and hatchery performance (e.g., no steelhead have been released since 2012 due to low returns of adult steelhead). While natural returns typically outnumber hatchery returns for all species, the proportion of the adult salmon escapement composed of Iron Gate Hatchery returns has historically been substantial. For fall-run Chinook salmon, around 35 percent of age 3 returning adults to the mid-Klamath River are Iron Gate Hatchery-produced (KRTT 2011, 2012, 2015), as well as approximately 30 percent of all coho salmon adult returns (CDFW 2014b, detailed in Section 3.3.5.9 *Aquatic Resource Impacts*). Under current conditions, no adult steelhead returning have been hatchery-produced since around 2012.

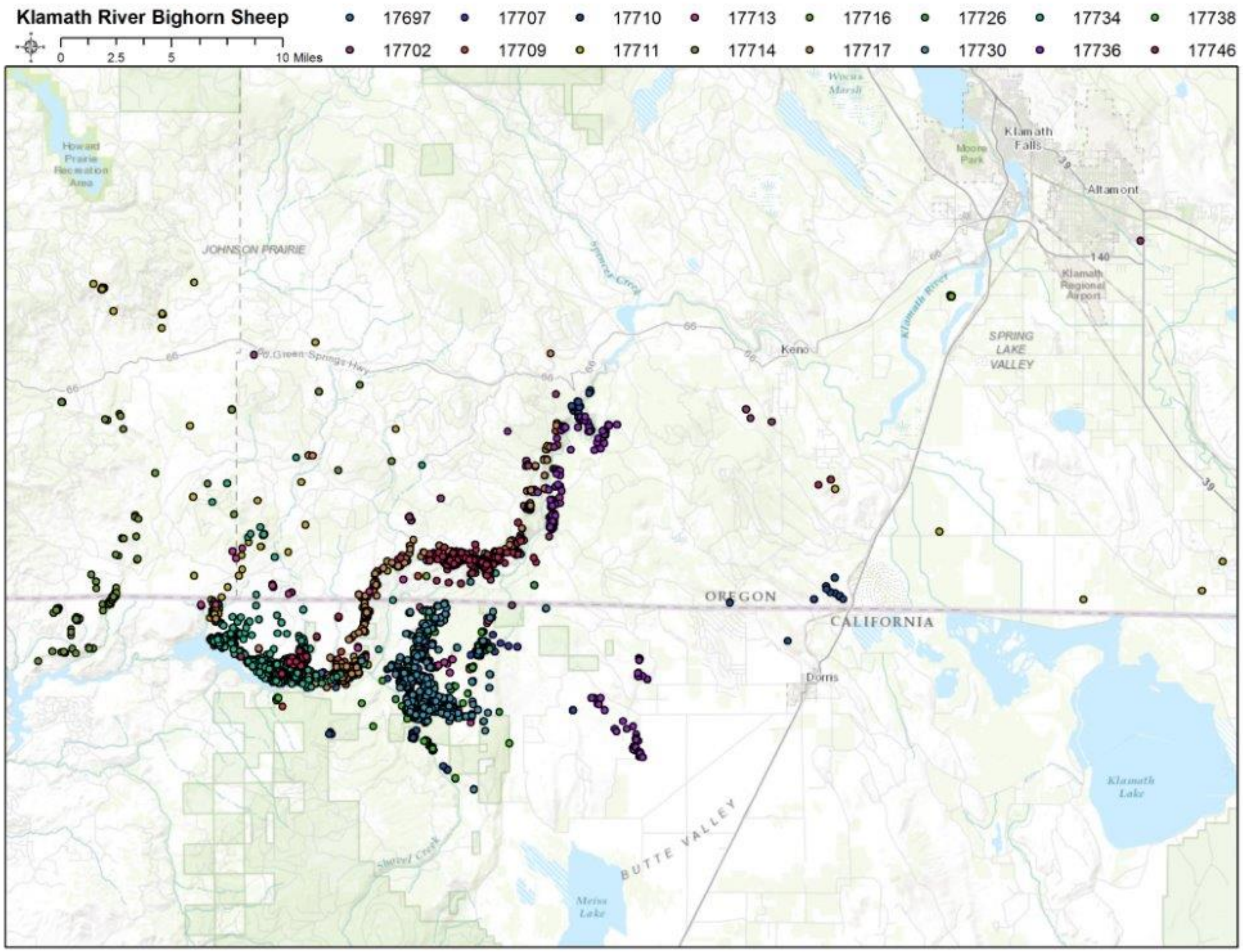

Figure 3.5-6. Bighorn Sheep 2017 Collar Data for the Klamath Basin (M. Harris, Senior Environmental Scientist, CDFW, pers. comm., October 2017).

3.5.2.5 Special-status Species

The list of special-status species known, or with the potential to occur, in the Primary Area of Analysis for terrestrial resources was developed by querying the following:

- CNDDB list of state and federal proposed endangered, threatened, candidate species, including those with BLM sensitive status (CDFW 2017a);
- USFWS list of federally listed and proposed endangered, threatened, and candidate species (USFWS 2017b);
- California Native Plant Society (CNPS) online Inventory of Rare and Endangered Vascular Plants of California (CNPS 2017);
- USDA Forest Service Pacific Southwest Region's (Region 5) documented occurrences of sensitive animals and sensitive and special interest plants (USDA Forest Service 2003 and 2017b);
- BLM species list (S. Acridge, Resource Management Supervisor, BLM, pers. comm., July 2017); and
- NMFS West Coast Region species list of endangered and threatened species and critical habitat (2017).

The database queries for CNDDB, USFWS, and CNPS were each based on a search of the Proposed Project Vicinity, which includes the USGS 7.5-minute quadrangles in which the Primary Area of Analysis for terrestrial resources is located and the adjacent quadrangles (Appendix I). Occurrence information for special-status species was based on studies conducted by PacifiCorp, KRRC, and available information on the presence of birds in the area from the eBird database (eBird 2018).

PacifiCorp conducted focused surveys for special-status species in 2002, 2003, and 2004 (PacifiCorp 2004a,b). These results are incorporated into Appendix J, which lists all positive occurrence data for special-status species within the Proposed Project Vicinity. PacifiCorp collected wildlife data in 2002 and/or 2003 which included, but was not limited to, the following types of surveys: breeding amphibians in ponds and wetlands; stream-dwelling amphibians in selected tributary streams; upland amphibian surveys; Oregon spotted frog surveys at four wetlands near J.C. Boyle and Keno reservoirs; foothill yellow-legged frog surveys at ten Klamath River mainstem and tributary sites meeting basic criteria for habitat suitability; western pond turtle basking surveys and suitable nesting habitat mapping; snake hibernacula surveys focused on areas located between roads/recreation sites and the river and selected rock talus areas; upland reptile surveys at 137 plots; small mammal trapping and track surveys with bat stations; bat roost surveys; bird surveys using avian point count and area searches in survey plots and along reservoir and shoreline habitats; protocol surveys for northern spotted owl and northern goshawk, and broadcast calls for great gray owls; and data collected opportunistically during other studies (e.g., fish electrofishing).

Results of wildlife surveys conducted by KRRC in 2017 and available data from 2018 are incorporated into this analysis and are also provided in Appendix B: *Definite Plan – Appendix J* and KRRC (CDM Smith 2018c,d); some surveys are anticipated to continue into 2019.

Special-status Plants

Table 3.5-4 lists the special-status plant species with potential to occur in the Primary Area of Analysis for terrestrial resources based on the CNDDB, USFWS, and CNPS database queries (plant species elevation information in CDFW 2017a and CNPS 2017 is provided in metric units). Fifty-three of these species are associated with wetland and/or riparian habitats. Species that were documented in the Proposed Project Vicinity but have an elevation range that is higher than the Primary Area of Analysis for terrestrial resources or that occur in habitats not represented in the Primary Area of Analysis were excluded. The number of species that have been documented in the Primary Area of Analysis for terrestrial resources and are included in the CNDDB, USFWS, and/or CNPS database includes 14 special-status vascular and three special-status bryophyte species. Although not present in the CNDDB, USFWS, and CNPS databases, Egg Lake monkey-flower (*Mimulus pygmaeus*) was documented in the vicinity of Fall Creek Dam A/B – City of Yreka Water Supply Diversion (Figure 2.7-15) during the CDM Smith's 2018 surveys (CDM Smith 2018b); this species has a California Rare Plant Rank (CRPR) status of 4.2 and is found on volcanic and clay soils in vernally mesic areas including Great Basin scrub, lower montane coniferous forest, meadows and seeps and pinyon and juniper woodlands. No federally listed or state-listed species have been documented within the Primary Area of Analysis for terrestrial resources but 11 have the potential to occur.

Table 3.5-4. Special-status Plant Species with the Potential to Occur in the Primary Area of Analysis for Terrestrial Resources.

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Vascular Plants						
Abronia umbellata var. *breviflora*	pink sand-verbena	–/–/–/BLMS/1B.1	June–October	0–10	Coastal dunes	Potential habitat within the Primary Area of Analysis
Allium siskiyouense	Siskiyou onion	–/–/–/–/4.3	(April) May–July	855–2,500	Rocky and sometimes serpentine soils in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Androsace elongata subsp. *acuta*	California androsace	–/–/–/–/4.2	March–June	150–1,305	Chaparral, cismontane woodland, coastal scrub, meadows and seeps, pinyon and juniper woodland, and valley and foothill grassland	Potential habitat within the Primary Area of Analysis
Angelica lucida	sea-watch	–/–/–/–/4.2	May–September	0–150	Coastal bluff scrub, coastal dunes, coastal scrub, and coastal salt marshes and swamps	Potential habitat within the Primary Area of Analysis
Antennaria suffrutescens	evergreen everlasting	–/–/–/–/4.3	January–July	500–1,600	Serpentine soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Arabis aculeolata	Waldo rockcress	–/–/–/–/2B.2	April–June	410–1,800	Serpentine soils in broadleafed upland forest, lower montane coniferous forest, and upper montane coniferous forest	Documented within the Primary Area of Analysis (CDFW 2017a).
Arabis mcdonaldiana	McDonald's rockcress	FE/CE/–/FSS/1B.1	May–July	135–1,800	Serpentine soils in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Arabis modesta	modest rockcress	–/–/–/–/4.3	March–July	120–800	Chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Arabis oregana	Oregon rockcress	–/–/–/–/4.3	May	600–1,830	Serpentine soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Arctostaphylos hispidula	Howell's manzanita	–/–/–/–/4.2	March–April	120–1,250	Serpentine or sandstone soils in chaparral	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Arctostaphylos nortensis	Del Norte manzanita	–/–/–/–/4.3	February	500–800	Often serpentine soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Arnica cernua	serpentine arnica	–/–/–/–/4.3	April–July	500–1,920	Serpentine soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Arnica spathulata	Klamath arnica	–/–/–/–/4.3	May–August	640–1,800	Serpentine soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Asarum marmoratum	marbled wild-ginger	–/–/–/–/2B.3	April–August	200–1,800	Lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Astragalus umbraticus	Bald Mountain milk-vetch	–/–/–/–/2B.3	May–August	150–1,250	Sometimes on roadsides in cismontane woodland and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Balsamorhiza lanata	woolly balsamroot	–/–/–/BLMS/1B.2	April–June	800–1,895	Rocky, volcanic soils in cismontane woodland	Potential habitat within the Primary Area of Analysis
Bensoniella oregana	bensoniella	–/CR/FSS/–/1B.1	May-July	915–1,400	Bogs and fens, lower montane coniferous forest, meadows and seeps	Potential habitat within the Primary Area of Analysis
Boechera koehleri	Koehler's stipitate rockcress	–/–/FSS/–/1B.3	(March) April–July	155–1,660	Serpentine, rocky soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Calamagrostis bolanderi	Bolander's reed grass	–/–/–/–/4.2	May–August	0–455	Mesic soils in bogs and fens, broadleafed upland forest, closed-cone coniferous forest, coastal scrub, meadows and seeps, freshwater marshes and swamps, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Calamagrostis crassiglumis	Thurber's reed grass	–/–/–/–/2B.1	May–August	10–60	Mesic soils in coastal scrub and freshwater marshes and swamps	Potential habitat within the Primary Area of Analysis
Calamagrostis foliosa	leafy reed grass	–/CR/–/BLMS/4.2	May–September	0–1,220	Rocky soils in coastal bluff scrub and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Callitropsis nootkatensis	Alaska cedar	Petition to list/–/–/–/4.3		650–2,500	Upper montane coniferous forest	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Calochortus greenei	Greene's mariposa lily	–/–/FSS/BLMS/1B.2	June–August	1,035–1,890	Volcanic soils in cismontane woodland, meadows and seeps, pinyon and juniper woodland, and upper montane coniferous forest	Documented during PacifiCorp surveys at Iron Gate Reservoir, Copco No. 1 & No. 2 (PacifiCorp 2004a; CDMB Smith 2018b). Several occurrences on CNDDB along Klamath River (2017a).
Calochortus monanthus	single-flowered mariposa lily	–/–/–/BLMS/1A	June	745–800	Meadows and seeps	Potential habitat within the Primary Area of Analysis
Calochortus persistens	Siskiyou mariposa lily	–/CR/FSS/BLMS/1B.2	June–July	1,000–1,860	Rocky, acidic soils in lower montane coniferous forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Calycadenia micrantha	small-flowered calycadenia	–/–/FSS/–/1B.2	June-September	5–1,500	Roadsides, rocky, talus, scree, sometimes serpentine soils and sparsely vegetated areas in chaparral, volcanic meadows and seeps, and valley and foothill grassland	Potential habitat within the Primary Area of Analysis
Cardamine angulata	seaside bittercress	–/–/–/–/2B.1	(January) March–July	25–915	Wet areas and streambanks in lower montane coniferous forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Carex buxbaumii	Buxbaum's sedge	–/–/–/–/4.2	March–August	3–3,300	Bogs and fens, mesic soils in meadows and seeps, and marshes and swamps	Potential habitat within the Primary Area of Analysis
Carex hystericina	porcupine sedge	–/–/–/–/2B.1	May–June	610–915	Streambanks in marshes and swamps	Potential habitat within the Primary Area of Analysis
Carex lenticularis var. *limnophila*	lagoon sedge	–/–/–/–/2B.2	June–August	0–6	Often gravelly soils along shores, beaches in bogs and fens, marshes and swamps, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Carex leptalea	bristle-stalked sedge	–/–/–/–/2B.2	March–July	0–700	Bogs and fens, mesic areas of meadows and seeps, marshes and swamps	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Carex lyngbyei	Lyngbye's sedge	–/–/–/–/2B.2	April–August	0–10	Brackish or freshwater marshes and swamps	Potential habitat within the Primary Area of Analysis
Carex praticola	northern meadow sedge	–/–/–/–/2B.2	May–July	0–3,200	Mesic areas of meadows and seeps	Potential habitat within the Primary Area of Analysis
Carex saliniformis	deceiving sedge	–/–/–/–/1B.2	June (July)	3–230	Mesic soils in coastal prairie, coastal scrub, meadows and seeps, and coastal salt marshes and swamps	Potential habitat within the Primary Area of Analysis
Carex scabriuscula	Siskiyou sedge	–/–/–/–/4.3	May–July	710–2,345	Mesic, sometimes serpentine soils in lower montane coniferous forest, meadows and seeps, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Carex serpenticola	serpentine sedge	–/–/–/–/2B.3	March–May	60–1,200	Mesic, serpentine soils in meadows and seeps	Potential habitat within the Primary Area of Analysis
Carex viridula subsp. *viridula*	green yellow sedge	–/–/–/–/2B.3	(June) July–September (November)	0–1,600	Bogs and fens, freshwater marshes and swamps, and mesic North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Castilleja ambigua var. *humboldtiensis*	Humboldt Bay owl's-clover	–/–/–/BLMS/1B.2	April–August	0–3	Coatal salt marshes and swamps	Potential habitat within the Primary Area of Analysis
Castilleja brevilobata	short-lobed paintbrush	–/–/–/–/4.2	April–July	120–1,700	Serpentine soils and edges and openings in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Castilleja elata	Siskiyou paintbrush	–/–/–/–/2B.2	May–August	0–1,750	Often serpentine soils in bogs and fens, and seeps in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Castilleja litoralis	Oregon coast paintbrush	–/–/–/–/2B.2	June	15–100	Sandy soils in coastal bluff scrub, coastal dunes, and coastal scrub	Potential habitat within the Primary Area of Analysis
Chaenactis suffrutescens	Shasta chaenactis	–/–/–/–/1B.3	May–September	750–2,800	Sandy, serpentine soils in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Chamaesyce hooveri	Hoover's Spurge	FT/–/–/–/1B.2	July–September (October)	25–250	Vernal pools	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Chrysosplenium glechomifolium	Pacific golden saxifrage	–/–/–/–/4.3	February–June	10–220	Streambanks, sometimes seeps, sometimes roadsides in North Coast coniferous forest, and riparian forest	Potential habitat within the Primary Area of Analysis
Cirsium ciliolatum	Ashland thistle	–/CE/–/BLMS/2B.1	June–August	800–1,400	Cismontane woodland and valley and foothill grassland	Potential habitat within the Primary Area of Analysis
Collomia tracyi	Tracy's collomia	–/–/–/–/4.3	June–July	300–2,100	Rocky, sometimes serpentine soils in broadleafed upland forest and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Coptis laciniata	Oregon goldthread	–/–/–/–/4.2	(February) March–May (September–November)	0–1,000	Mesic soils in meadows and seeps and streambanks in North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Cornus canadensis	bunchberry	–/–/–/–/2B.2	May–July	60–1,920	Bogs and fens, meadows and seeps, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Cypripedium californicum	California lady's-slipper	–/–/–/–/4.2	April–August (September)	30–2,750	Usually serpentine soils in bogs and fens, seeps and streambanks and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Cypripedium fasciculatum	clustered lady's-slipper	–/–/FSS/–/4.2	March–August	100–2,435	Usually serpentine soils in seeps and streambanks, lower montane coniferous forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Cypripedium montanum	mountain lady's-slipper	–/–/FSS/–/4.2	March–August	185–2,225	Broadleafed upland forest, cismontane woodland, lower montane coniferous forest, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Darlingtonia californica	California pitcherplant	–/–/–/–/4.2	April–August	0–2,585	Serpentine soils in bogs and fens, and meadows and seeps	Potential habitat within the Primary Area of Analysis
Dicentra formosa subsp. *oregana*	Oregon bleeding heart	–/–/–/–/4.2	April–May	425–1,485	Serrpentinite soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Draba carnosula	Mt. Eddy draba	–/–/FSS/–/1B.3	July–August	1,935–3,000	Serpentine, rocky soils in subalpine coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Empetrum nigrum	black crowberry	–/–/–/–/2B.2	April–June	10–200	Coastal bluff scrub and coastal prairie	Potential habitat within the Primary Area of Analysis
Epilobium oreganum	Oregon fireweed	–/–/FSS/BLMS/1B.2	June–September	500–2,240	Mesic soils in bogs and fens, lower montane coniferous forest, meadows and seeps, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Epilobium rigidum	Siskiyou Mountains willowherb	–/–/–/–/4.3	July–August	150–1,200	Serpentine soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Epilobium septentrionale	Humboldt County fuchsia	–/–/–/–/4.3	July–September	45–1,800	Sandy or rocky soils in broadleafed upland forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Erigeron bloomeri var. *nudatus*	Waldo daisy	–/–/–/–/2B.3	June–July	600–2,300	Serpentine soils in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Eriogonum congdonii	Congdon's buckwheat	–/–/–/–/4.3	(May) June–August (September)	800–2,345	Rocky, serpentine soils in lower montane coniferous forest openings	Potential habitat within the Primary Area of Analysis
Eriogonum hirtellum	Klamath Mountain buckwheat	–/–/FSS/–/1B.3	July–September	610–1,900	Serpentine soils in chaparral, lower montane coniferous forest, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Eriogonum nudum var. *paralinum*	Del Norte buckwheat	–/–/–/–/2B.2	June–September	5–80	Coastal bluff scrub and coastal prairie	Documented within the Primary Area of Analysis (CDFW 2017a)
Eriogonum siskiyouense	Siskiyou buckwheat	–/–/–/–/4.3	(June) July–September	970–2,740	Rocky, often serpentine soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Eriogonum ternatum	ternate buckwheat	–/–/–/–/4.3	June–August	305–2,225	Serpentine soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Eriogonum ursinum var. *erubescens*	blushing wild buckwheat	–/–/–/BLMS/1B.3	June–September	750–1,900	Rocky soils, scree, and talus in montane chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Erysimum concinnum	bluff wallflower	–/–/–/–/1B.2	February–July	0–185	Coastal bluff scrub, coastal dunes, and coastal prairie	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Erysimum menziesii	Menzies' Wallflower	FT/CE/–/–/1B.1	March–September	0–35	Coastal dunes	Potential habitat within the Primary Area of Analysis
Erythronium hendersonii	Henderson's fawn lily	–/–/FSS/–/2B.3	April–July	300–1,600	Lower montane coniferous forest	Documented within the Primary Area of Analysis (CDFW 2017a)
Erythronium howellii	Howell's fawn lily	–/–/–/–/1B.3	April–May	200–1,145	Sometimes serpentine soils in lower montane coniferous forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Erythronium oregonum	giant fawn lily	–/–/–/–/2B.2	March–June (July)	100–1,150	Sometimes serpentine soils and in rocky openings in cismontane woodland and meadows and seeps	Documented within the Primary Area of Analysis (CDFW 2017a)
Erythronium revolutum	coast fawn lily	–/–/–/–/2B.2	March–July (August)	0–1,600	Bogs and fens, streambanks, broadleafed upland forest, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Eucephalus vialis	wayside aster	–/–/FSS/–/1B.2	June–September	910–1,545	Gravelly soils in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Fritillaria gentneri	Gentner's fritillary	FE/–/–/–/1B.1	April–May	1,005–2,970	Sometimes serpentine soils in chaparral, cismontane woodland, and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Galium serpenticum subsp. *scotticum*	Scott Mountain bedstraw	–/–/–/BLMS/1B.2	May–August	1,000–2,075	Serpentine soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Gentiana setigera	Mendocino gentian	–/–/FSS/–/1B.2	(April–July) August–September	335–1,065	Mesic soils in lower montane coniferous forest, and meadows and seeps	Potential habitat within the Primary Area of Analysis
Gilia capitata subsp. *pacifica*	Pacific gilia	–/–/–/–/1B.2	April–August	5–1,665	Coastal bluff scrub, openings in chaparral, coastal prairie, and valley and foothill grassland	Potential habitat within the Primary Area of Analysis
Gilia millefoliata	dark-eyed gilia	–/–/–/BLMS/1B.2	April–July	2–30	Coastal dunes	Potential habitat within the Primary Area of Analysis
Glehnia littoralis subsp. *leiocarpa*	American glehnia	–/–/–/–/4.2	May–August	0–20	Coastal dunes	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Helianthus bolanderi	serpentine sunflower	–/–/–/–/4.2	June-November	150–1,525	Serpentine seeps in chaparral and cismontane woodland	Documented during PacifiCorp surveys south of Iron Gate Reservoir (PacifiCorp 2004a)
Hesperocyparis bakeri	Baker cypress	–/–/–/–/4.2		820–1,995	Serpentine or volcanic soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Horkelia sericata	Howell's horkelia	–/–/–/–/4.3	May–July	60–1,280	Serpentine or clay soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Hymenoxys lemmonii	alkali hymenoxys	–/–/–/–/2B.2	June–August (September)	240–3,390	Great Basin scrub, lower montane coniferous forest, and subalkaline meadows and seeps	Potential habitat within the Primary Area of Analysis
Iliamna latibracteata	California globe mallow	–/–/FSS/–/1B.2	June–August	60–2,000	Montane chaparral, lower montane coniferous forest, mesic soils in North Coast coniferous forest, and streambanks in riparian scrub. Often in burned areas	Potential habitat within the Primary Area of Analysis
Iris bracteata	Siskiyou iris	–/–/–/–/3.3	May–June	180–1,070	Serpentine soils in broadleafed upland forest and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Iris innominata	Del Norte County iris	–/–/–/–/4.3	May–June	300–2,000	Serpentine soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Iris tenax subsp. *klamathensis*	Orleans iris	–/–/–/–/4.3	April–May	100–1,400	Lower montane coniferous forest, often in disturbed areas	Potential habitat within the Primary Area of Analysis
Juncus dudleyi	Dudley's rush	–/–/–/–/2B.3	July–August	455–2,000	Mesic soils in lower montane coniferous forest	Documented within the Primary Area of Analysis (CDFW 2017a)
Juncus regelii	Regel's rush	–/–/–/–/2B.3	August	760–1,900	Mesic soils in meadows and seeps and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Kopsiopsis hookeri	small groundcone	–/–/–/–/2B.3	April–August	90–885	North Coast coniferous forest	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Lathyrus delnorticus	Del Norte pea	–/–/–/–/4.3	June–July	30–1,450	Often serpentine soils in lower montane coniferous forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Lathyrus japonicus	seaside pea	–/–/–/–/2B.1	May–August	1–30	Coastal dunes	Potential habitat within the Primary Area of Analysis
Lathyrus palustris	marsh pea	–/–/–/–/2B.2	March–August	1–100	Mesic soils in bogs and fens, coastal prairie, coastal scrub, lower montane coniferous forest, marshes and swamps, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Layia carnosa	beach layia	FE/CE/–/–/1B.1	March–July	0–60	Coastal dunes, and sandy soils in coastal scrub	Potential habitat within the Primary Area of Analysis
Lewisia cotyledon var. *heckneri*	Heckner's lewisia	–/–/–/BLMS/1B.2	May–July	225–2,100	Rocky soils in lower montane coniferous forest	Documented within the Primary Area of Analysis (CDFW 2017a)
Lewisia cotyledon var. *howellii*	Howell's lewisia	–/–/–/–/3.2	April–July	150–2,010	Rocky soils in broadleafed upland forest, chaparral, cismontane woodland, and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Lewisia kelloggii subsp. *hutchisonii*	Hutchison's lewisia	–/–/–/–/3.2	(April) May–August	765–2,365	Openings, ridgetops, often slate, sometimes rhyolite tuff in upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Lewisia oppositifolia	opposite-leaved lewisia	–/–/FSS/–/2B.2	April-May (June)	300–1,220	Mesic soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Lilium bolanderi	Bolander's lily	–/–/–/–/4.2	June–July	30–1,600	Serpentine soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Lilium occidentale	western lily	FE/CE/–/–/1B.1	June–July	2–185	Bogs and fens, coastal bluff scrub, coastal prairie, coastal scrub, freshwater marshes and swamps, and openings in North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Lilium pardalinum subsp. *vollmeri*	Vollmer's lily	–/–/–/–/4.3	(June) July–August	30–1,680	Bogs and fens, and mesic soils in meadows and seeps	Potential habitat within the Primary Area of Analysis

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Lilium pardalinum subsp. *wigginsii*	Wiggins' lily	–/–/–/–/4.3	June–August	485–2,000	Mesic soils in bogs and fens, broadleafed upland forest, lower montane coniferous forest, meadows and seeps, and riparian scrub	Potential habitat within the Primary Area of Analysis
Lilium rubescens	redwood lily	–/–/–/–/4.2	April–August (September)	30–1,910	Sometimes serpentine soils in broadleafed upland forest, chaparral, lower montane coniferous forest, North Coast coniferous forest, and upper montane coniferous forest. Sometimes roadsides	Potential habitat within the Primary Area of Analysis
Limnanthes floccosa subsp. *floccosa*	woolly meadowfoam	–/–/–/–/4.2	March–May (June)	60–1,335	Vernally mesic soils in chaparral, cismontane woodland, and valley and foothill grassland, and vernal pools	Potential habitat within the Primary Area of Analysis
Listera cordata	heart-leaved twayblade	–/–/–/–/4.2	February–July	5–1,370	Bogs and fens, lower montane coniferous forest, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Lomatium howellii	Howell's lomatium	–/–/–/–/4.3	April–July	110–1,705	Serpentine soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Lomatium martindalei	Coast Range lomatium	–/–/–/–/2B.3	May–June(August)	240–3,000	Coastal bluff scrub, lower montane coniferous forest, and meadows and seeps	Potential habitat within the Primary Area of Analysis
Lomatium peckianum	Peck's lomatium	–/–/–/–/2B.2	April–May (June)	700–1,800	Volcanic soils in chaparral, cismontane woodland, lower montane coniferous forest, and pinyon and juniper woodland	Documented within the Primary Area of Analysis (CDFW 2017a)
Lomatium tracyi	Tracy's lomatium	–/–/–/–/4.3	May–June	455–1,950	Serpentine soils in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis

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Lupinus tracyi	Tracy's lupine	–/–/–/–/4.3	(May) June–July	895–2,000	Upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Lycopodiella inundata	inundated bog club-moss	–/–/–/–/2B.2	June–September	5–1,000	Coastal bogs and fens, mesic soils in lower montane coniferous forest, marshes and swamps and lake margins	Potential habitat within the Primary Area of Analysis
Lycopodium clavatum	running-pine	–/–/–/–/4.1	June–August (September)	45–1,225	Often edges, openings, and roadsides in mesic soils in lower montane coniferous forest and North Coast coniferous forest, and marshes and swamps	Potential habitat within the Primary Area of Analysis
Lysimachia europaea	arctic starflower	–/–/–/–/2B.2	June–July	0–15	Coastal bogs, fens, meadows, and seeps	Potential habitat within the Primary Area of Analysis
Micranthes marshallii	Marshall's saxifrage	–/–/–/–/4.3	March–August	90–2,130	Riparian forest, rocky steambanks	Potential habitat within the Primary Area of Analysis
Microseris laciniata subsp. *detlingii*	Detling's silverpuffs	–/–/–/–/2B.2	May–June	600–1,500	Clay soils in openings in cismontane woodland	Documented within the Primary Area of Analysis (CDFW 2017a)
Mitellastra caulescens	leafy-stemmed mitrewort	–/–/–/–/4.2	(March) April–October	5–1,700	Mesic soils in broadleafed upland forest, lower montane coniferous forest, meadows and seeps, and North Coast coniferous forest. Sometimes roadsides	Potential habitat within the Primary Area of Analysis
Moneses uniflora	woodnymph	–/–/–/–/2B.2	May–August	100–1,100	Broadleafed upland forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Monotropa uniflora	ghost-pipe	–/–/–/–/2B.2	June–August (September)	10–550	Broadleafed upland forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Montia howellii	Howell's montia	–/–/–/–/2B.2	(February) March–May	0–835	Meadows and seeps, North Coast coniferous forest, and vernal pools. Sometimes roadsides	Potential habitat within the Primary Area of Analysis

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Oenothera wolfii	Wolf's evening-primrose	–/–/–/BLMS/1B.1	May–October	3–800	Sandy, usually mesic soils in coastal bluff scrub, coastal dunes, coastal prairie, and lower montane coniferous forest	Documented within the Primary Area of Analysis (CDFW 2017a)
Opuntia fragilis	brittle prickly-pear	–/–/–/–/2B.1	April–July	820–880	Volcanic soils in pinyon and juniper woodland	Potential habitat within the Primary Area of Analysis
Orcuttia tenuis	Slender Orcutt Grass	FT/CE/–/–/1B.1	May–September (October)	35–1,760	Often in gravelly vernal pools	Potential habitat within the Primary Area of Analysis
Orthocarpus pachystachyus	Shasta orthocarpus	–/–/–/BLMS/1B.1	May	840–850	Great Basin scrub, meadows and seeps, and valley and foothill grassland	Potential habitat within the Primary Area of Analysis
Oxalis suksdorfii	Suksdorf's wood-sorrel	–/–/–/–/4.3	May–August	15–700	Broadleafed upland forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Packera bolanderi var. *bolanderi*	seacoast ragwort	–/–/–/–/2B.2	(Jan–April) May–July (August)	30–650	Coastal scrub and North Coast coniferous forest. Sometimes roadsides	Potential habitat within the Primary Area of Analysis
Packera hesperia	western ragwort	–/–/FSS/–/2B.2	April-June	500–2,500	Serpentine soils in meadows and seeps and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Packera macounii	Siskiyou Mountains ragwort	–/–/–/–/4.3	June–July	400–915	Sometimes serpentine, often in disturbed areas in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Penstemon cinicola	ash beardtongue	–/–/–/–/4.3	June–August (September)	730–2,685	Volcanic, sandy or rocky soils in lower montane coniferous forest, meadows and seeps, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Penstemon filiformis	thread-leaved beardtongue	–/–/–/BLMS/1B.3	May–August (September)	450–1,875	Rocky, often serpentine soils in cismontane woodland and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis

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Phacelia greenei	Scott Valley phacelia	–/–/–/BLMS/1B.2	April–June	800–2,440	Serpentine soils in closed-cone coniferous forest, lower montane coniferous forest, subalpine coniferous forest, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Phlox hirsuta	Yreka phlox	FE/CE/–/–/1B.2	March–April	760–1,500	Serpentine soils, talus in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Pinguicula macroceras	horned butterwort	–/–/–/–/2B.2	April–June	40–1,920	Serpentine soils in bogs and fens	Potential habitat within the Primary Area of Analysis
Piperia candida	white-flowered rein orchid	–/–/–/BLMS/1B.2	(March) May–September	30–1,310	Sometimes serpentine soils in broadleafed upland forest, lower montane coniferous forest, and North Coast coniferous forest	Documented within the Primary Area of Analysis (CDFW 2017a)
Pityopus californicus	California pinefoot	–/–/–/–/4.2	(March–April) May–August	15–2,225	Mesic soils in broadleafed upland forest, lower montane coniferous forest, North Coast coniferous forest, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Pleuropogon refractus	nodding semaphore grass	–/–/–/–/4.2	(March) April–August	0–1,600	Mesic soils in lower montane coniferous forest, meadows and seeps, North Coast coniferous forest, and riparian forest	Potential habitat within the Primary Area of Analysis
Poa piperi	Piper's blue grass	–/–/–/–/4.3	April–May	100–1,460	Serpentine, rocky soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Polemonium carneum	Oregon polemonium	–/–/–/–/2B.2	April–September	0–1,830	Coastal prairie, coastal scrub, and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Potamogeton foliosus subsp. *fibrillosus*	fibrous pondweed	–/–/–/–/2B.3	July–October	5–1,300	Shallow freshwater marshes and swamps	Potential habitat within the Primary Area of Analysis
Prosartes parvifolia	Siskiyou bells	–/–/FSS/–/1B.2	May–September	700–1,525	Often roadsides, disturbed areas, and burned areas in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis

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Pyrrocoma racemosa var. *congesta*	Del Norte pyrrocoma	–/–/–/–/2B.3	August–September	200–1,000	Serpentine soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Ribes laxiflorum	trailing black currant	–/–/–/–/4.3	March–July(August)	5–1,395	North Coast coniferous forest, sometimes roadsides	Potential habitat within the Primary Area of Analysis
Romanzoffia tracyi	Tracy's romanzoffia	–/–/–/–/2B.3	March–May	15–30	Rocky soils in coastal bluff scrub and coastal scrub	Potential habitat within the Primary Area of Analysis
Rosa gymnocarpa var. *serpentina*	Gasquet rose	–/–/–/–/1B.3	April–June(August)	400–1,725	Serpentine soils, often roadsides, sometimes ridges, streambanks, and openings in chaparral and cismontane woodland	Potential habitat within the Primary Area of Analysis
Rubus nivalis	snow dwarf bramble	–/–/–/–/2B.3	June–August	1,085–1,350	North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Sabulina howellii	Howell's sandwort	–/–/–/BLMS/1B.3	April–July	550–1,000	Serpentine and xeric soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Salvia dorrii var. *incana*	fleshy sage	–/–/–/–/3	May–July	300–1,295	Great Basin scrub and pinyon and juniper woodland	Documented during PacifiCorp surveys at Iron Gate Reservoir and along Klamath River from Iron Gate Dam to Shasta River (PacifiCorp 2004a)
Sanguisorba officinalis	great burnet	–/–/–/–/2B.2	July–October	60–1,400	Often serpentine soils in bogs and fens, broadleafed upland forest, meadows and seeps, marshes and swamps, North Coast coniferous forest, and riparian forest	Potential habitat within the Primary Area of Analysis
Sanicula peckiana	Peck's sanicle	–/–/–/–/4.3	March, May, June	150–800	Often serpentine soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Sanicula tracyi	Tracy's sanicle	–/–/FSS/–/4.2	April–July	100–1,585	Openings in cismontane woodland, lower montane coniferous forest, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Schoenoplectus subterminalis	water bulrush	–/–/–/–/2B.3	June–August(September)	750–2,250	Bogs and fens, marshes and swamps and montane lake margins	Potential habitat within the Primary Area of Analysis

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Scirpus pendulus	pendulous bulrush	–/–/–/–/2B.2	June, August	800–1,000	Mesic meadows and seeps, and freshwater marshes and swamps	Potential habitat within the Primary Area of Analysis
Sedum citrinum	Blue Creek stonecrop	–/–/–/–/1B.2	June	1,050–1,280	Serpentine and rocky soils in North Coast coniferous forest, talus, scree, or boulder crevices; sometimes roadsides	Potential habitat within the Primary Area of Analysis
Sedum laxum subsp. *flavidum*	pale yellow stonecrop	–/–/–/–/4.3	May–July	455–2,000	Serpentine or volcanic soils in broadleafed upland forest, chaparral, cismontane woodland, lower montane coniferous forest, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Sedum laxum subsp. *heckneri*	Heckner's stonecrop	–/–/–/–/4.3	June–July	100–2,100	Serpentine or gabbroic soils in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Sedum oblanceolatum	Applegate stonecrop	–/–/–/–/1B.1	June–July	400–2,000	Rocky soils and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Sedum obtusatum spp. paradisum	Canyon Creek stonecrop	–/–/FSS/–/1B.3	May-June	300–1,900	Granitic, rocky soils in broadleafed upland forest, chaparral, lower montane coniferous forest, and subalpine coniferous forest	Potential habitat within the Primary Area of Analysis
Sidalcea celata	Redding checkerbloom	–/–/–/–/3	April–August	135–1,525	Sometimes serpentine soils in cismontane woodland	Potential habitat within the Primary Area of Analysis
Sidalcea elegans	Del Norte checkerbloom	–/–/–/–/3.3	May–July	215–1,365	Serpentine soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Sidalcea malachroides	maple-leaved checkerbloom	–/–/–/–/4.2	(March) April–August	0–730	Often in disturbed areas in broadleafed upland forest, coastal prairie, coastal scrub, North Coast coniferous forest, and riparian woodland	Potential habitat within the Primary Area of Analysis
Sidalcea malviflora subsp. *patula*	Siskiyou checkerbloom	–/–/–/BLMS/1B.2	May–August	15–880	Often roadcuts in coastal bluff scrub, coastal prairie, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Sidalcea oregana subsp. *eximia*	coast checkerbloom	–/–/–/BLMS/1B.2	June–August	5–1,340	Lower montane coniferous forest, meadows and seeps, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis

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Silene marmorensis	Marble Mountain campion	–/–/–/–/1B.2	June, August	170–1,250	Broadleafed upland forest, chaparral, cismontane woodland, and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Silene serpentinicola	serpentine catchfly	–/–/FSS/–/1B.2	May–July	145–1,650	SerpentineOpenings in serpentine gravelly or rocky soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Smilax jamesii	English Peak greenbrier	–/–/–/BLMS/4.2	May–July (August–October)	505–1,975	Streambanks and lake margins, mesic depressions, broadleafed upland forest, lower montane coniferous forest, marshes and swamps, North Coast coniferous forest, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Strepthanthus howellii	Howell's jewelflower	–/–/FSS/–/1B.2	July-August	305–1,500	Serpentine, rocky soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Strepthanthus oblanceolatus	Trinity River jewelflower	–/–/FSS/–/1B.2	April-June	20–420	Cismontane woodland	Potential habitat within the Primary Area of Analysis
Tauschia glauca	glaucous tauschia	–/–/–/–/4.3	April–June	80–1,700	Gravelly, serpentine soils in lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Thermopsis gracilis	slender false lupine	–/–/–/–/4.3	March–July	100–1,720	Chaparral, cismontane woodland, lower montane coniferous forest, meadows and seeps, and North Coast coniferous forest. Sometimes roadsides	Potential habitat within the Primary Area of Analysis
Thermopsis robusta	robust false lupine	–/–/FSS/–/1B.2	May–July	150–1,500	Broadleafed upland forest and North Coast coniferous forest	Documented within the Primary Area of Analysis (CDFW 2017a)
Tiarella trifoliata var. *trifoliata*	trifoliate laceflower	–/–/–/–/3.2	(May) June–August	170–1,500	Edges, moist shady streambanks in lower montane coniferous forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Tracyina rostrata	beaked tracyina	–/–/FSS/–/1B.2	May-June	90–750	Chaparral, cismontane woodland, and valley and foothill grassland	Potential habitat within the Primary Area of Analysis
Trifolium siskiyouense	Siskiyou clover	–/–/–/–/1B.1	June–July	880–1,500	Mesic meadows and seeps, sometimes streambanks	Potential habitat within the Primary Area of Analysis

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Trillium ovatum subsp. *oettingeri*	Salmon Mountains wakerobin	–/–/–/–/4.2	February–July	855–2,024	Mesic soils in lower montane coniferous forest, riparian scrub, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Triteleia grandiflora	large-flowered triteleia	–/–/–/–/2B.1	April–June	700–1,500	Great Basin scrub and Pinyon and juniper woodland	Potential habitat within the Primary Area of Analysis
Triteleia hendersonii	Henderson's triteleia	–/–/–/–/2B.2	May–July	760–1,200	Cismontane woodland	Potential habitat within the Primary Area of Analysis
Vaccinium coccineum	Siskiyou Mountains huckleberry	–/–/–/–/3.3	June–August	1,095–2,135	Often serpentine soils in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Vaccinium scoparium	little-leaved huckleberry	–/–/–/–/2B.2	June–August	1,036–2,200	Rocky soils in subalpine coniferous forest	Potential habitat within the Primary Area of Analysis
Veratrum insolitum	Siskiyou false-hellebore	–/–/–/–/4.3	June–August	45–1,635	Clay soils in chaparral and lower montane coniferous forest	Potential habitat within the Primary Area of Analysis
Viola howellii	Howell's violet	–/–/–/–/2B.2	May–June	655	North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Viola lanceolata ssp. *occidentalis*	western white bog violet	–/–/FSS/–/1B.2	April-September	100–990	Serpentine soils in bogs and fens, marshes and swamps	Potential habitat within the Primary Area of Analysis
Viola palustris	alpine marsh violet	–/–/–/–/2B.2	March–August	0–150	Coastal bogs and fens and mesic coastal scrub	Potential habitat within the Primary Area of Analysis
Viola primulifolia subsp. *occidentalis*	western white bog violet	–/–/–/–/1B.2	April–September	100–990	Serpentine bogs and fens and marshes and swamps	Potential habitat within the Primary Area of Analysis
Bryophytes						
Anomobryum julaceum	slender silver moss	–/–/–/–/4.2	N/A	100–1,000	Damp rock and soil on outcrops, usually on roadcuts in broadleafed upland forest, lower montane coniferous forest, and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Buxbaumia viridis	buxbaumia moss	–/–/FSS/BLMS/2B.2	N/A	975–2,200	Fallen wood or humus in lower montane coniferous forest, subalpine coniferous forest, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Discelium nudum	naked flag moss	–/–/–/–/2B.2	N/A	10–50	Clay banks in coastal bluff scrub	Documented within the Primary Area of Analysis (CDFW 2017a)

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Fissidens pauperculus	minute pocket moss	–/–/FSS/–/1B.2	N/A	10–1,024	Damp coastal soil in North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Mielichhoferia elongata	elongate copper moss	–/–/FSS/–/4.3	N/A	0–1,960	Metamorphic rock, usually acidic, usually vernally mesic, and sometimes carbonate soils in broadleafed upland forest, chaparral, cismontane woodland, coastal scrub, lower montane coniferous forest, meadows and seeps, and subalpine coniferous forest	Potential habitat within the Primary Area of Analysis
Orthotrichum holzingeri	Holzinger's orthotrichum moss	–/–/–/–/1B.3	N/A	715–1,800	Usually on rock in and along streams, and rarely on tree limbs in cismontane woodland, lower montane coniferous forest, pinyon and juniper woodland, and upper montane coniferous forest	Documented within the Primary Area of Analysis (CDFW 2017a)
Ptilidium californicum	Pacific fuzz wort	–/–/–/BLMS/4.3	May–August	1,140–1,800	Usually epiphytic on live or dead trees, fallen and decaying logs, and stumps and rarely on humus over boulders in lower montane coniferous forest and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Trichodon cylindricus	cylindrical trichodon	–/–/–/–/2B.2	N/A	50–2,002	Sandy, exposed soil, roadbanks in broadleafed upland forest, meadows and seeps, and upper montane coniferous forest	Potential habitat within the Primary Area of Analysis
Triquetrella californica	coastal triquetrella	–/–/–/–/1B.2	N/A	10–100	Coastal bluff scrub and coastal scrub.	Documented within the Primary Area of Analysis (CDFW 2017a).
Lichen						
Bryoria pseudocapillaris	false gray horsehair lichen	–/–/–/–/3.2	N/A	0–90	Conifers in North Coast coniferous forest along the coast	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Calicium adspersum	spiral-spored guilded-head pin lichen	–/–/FSS/–/2B.2	N/A	200	Often restricted to bark of conifers over 200 years old in lower montane coniferous forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Peltigera gowardii	western waterfan lichen	–/–/FSS/–/4.2	N/A	1,065–2,620	On rocks in cold water creeks with little or no sediment or disturbance in riparian forest	Potential habitat within the Primary Area of Analysis
Ramalina thrausta	angel's hair lichen	–/–/FSS/–/2B.1	N/A	75–430	On dead twigs and other lichens in North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Sulcaria badia	groovy beard lichen	–/–/FSS/–/–	N/A	0–670	Mesic mixed hardwood/mid-mature *Pseudotsuga menziesii* forest, with additional hardwoods (*Quercus kelloggii*) occasional in the vicinity[4]	Potential habitat within the Primary Area of Analysis
Usnea longissima	Methuselah's beard lichen	–/–/–/BLMS/4.2	N/A	50–1,460	Tree branches, usually on old growth hardwoods and conifers in broadleafed upland forest and North Coast coniferous forest	Potential habitat within the Primary Area of Analysis
Fungi[5]						
Cudonia monticola		–/–/FSS/–/–	fruits primarily in spring	160–1,827	Common under conifers in mature moist coniferous forests in northern CA and the Pacific Northwest. Typically associated with very rotten wood	Potential habitat within the Primary Area of Analysis
Dendrocollybia racemosa	branched Collybia	–/–/FSS/–/–	fruits in autumn	Unknown	Grows on the remains of decayed mushrooms, or in duff of mixed hardwood-conifer woods in Pacific Northwest	Potential habitat within the Primary Area of Analysis
Otidea smithii		–/–/FSS/–/–	fruits August-December	381–1,144	Usually under conifer forests in Pacific Northwest and Norther California	Potential habitat within the Primary Area of Analysis
Phaeocollybia olivacea	Olive Phaeocollybia	–/–/FSS/–/–	fruits September-December	6–962	Grows on ground in mixed woods and under conifers in southern Oregon and northern California	Potential habitat within the Primary Area of Analysis

Scientific Name	Common Name	Status[1] Federal/ State/USDA Forest Service/ BLM/CRPR	Blooming Period[2,3]	Elevation Range (m)	California Habitat Associations[2]	Potential Habitat Or Documented Occurrence?
Rubroboletus pulcherrimus [Boletus pulcherrimus]	red-pored Bolete	–/–/FSS/–/–	fruits July–December	13–1,713	In mixed hardwood-conifer forests. Often found growing under conifers	Potential habitat within the Primary Area of Analysis
Tricholomopsis fulvescens		–/–/FSS/–/–	Unknown	above 1,000	Grows on rotting conifer logs in the Pacific Northwest and northern California	Potential habitat within the Primary Area of Analysis

[1] Status:
Federal
FE Federally Endangered
FT Federally Threatened
– No federal status
State
CE California State Endangered
CR California State Rare
– No state status
USDA Forest Service
FSS USDA-FS Sensitive
– No USDA-FS status
BLM
BLMS BLM Sensitive
– No BLM status
California Rare Plant Rank (CRPR; formerly known as CNPS Lists)
List 1B Plants rare, threatened, or endangered in California and elsewhere
List 2B Plants rare, threatened, or endangered in California, but more common elsewhere
List 3 More information needed about this plant, a review list
List 4 Plants of limited distribution, a watch list
– No CRPR status
CNPS Threat Ranks:
0.1 Seriously threatened in California (high degree/immediacy of threat)
0.2 Fairly threatened in California (moderate degree/immediacy of threat)
0.3 Not very threatened in California (low degree/immediacy of threats or no current threats known)

[2] CDFW (2017a), CNPS (2017) and Baldwin et al. (2012) unless otherwise cited.
[3] Species may bloom in months listed in parentheses but there are outside of the most common blooming range.
[4] USDA-FS 2012.
[5] Information sources include Aurora 1986, USDA_FS and BLM 2017.

Special-status Wildlife

To assess the possible effects of the Proposed Project on special-status species analyzed in this EIR, all special-status terrestrial wildlife species identified in the querying process described above (Section 3.5.2.5 *Special-status Species*) were evaluated for the potential to occur in the Proposed Project Vicinity (see Appendix Table J-3 for all wildlife species reviewed in the querying process) to determine inclusion for further analysis based on the following considerations: previously documented (including sightings from 1954) and known to occur in the Primary Area of Analysis for terrestrial resources, designated critical habitat is present in the Primary Area of Analysis, suitable habitat present in the Primary Area of Analysis, and/or potential to be affected by the Proposed Project. The 46 terrestrial special status determined to be appropriate for further analysis are six invertebrates, six amphibians, two reptiles, 23 birds, and nine mammals (Table 3.5-5). Habitat and occurrence information from CNDDB and 2002 and 2003 survey results from PacifiCorp (2004a) and 2018 surveys from KRRC (as referenced in Section 3.5.2.4 *Non-Special Status Wildlife*) are provided in Table 3.5.-5.

(see Section 3.3.2 *Environmental Setting* and Appendix Table A-1 for a discussion of aquatic special-status wildlife species such as Shasta crayfish, sea turtles, sea lion, and whales.)

Table 3.5-5. Suitable Habitat and Occurrence Information for Special-status Wildlife Species.

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Invertebrates			
Hooded lancetooth *Ancotrema voyanum*	--/--/BLMS	Limestone substrates, mostly in an elevation range of 550–3,100 feet	• Species was documented in 1992 approximately 4 miles southwest of Orleans and approximately 0.2 miles from the Klamath River (greater than 100 river miles (RM) downstream of Iron Gate Dam) (CDFW 2017a).
Oregon shoulderband *Helminthoglypta hertleini*	--/--/BLMS	Found on basaltic talus slopes where ground cover/moisture is present; adapted to dry conditions during a portion of the year	• Single occurrence has been documented approximately 100 RM downstream of Iron Gate Dam (no documentation date) (2017a).
Trinity shoulderband *Helminthoglypta talmadgei*	--/--/BLMS	Limestone rockslides, litter in coniferous forests, old mine tailings, and along shaded streams	• Single occurrence documented at mine tailings in 1954 more than 100 RM downstream of Iron Gate Dam (2017a).
Siskiyou shoulderband *Monadenia chaceana*	--/--/BLMS	Lower reaches of major drainages. Talus and rock slides, under rocks and woody debris in moist conifer forests, caves, and riparian corridors in shrubby areas	• Single occurrence has been documented approximately 0.25 RM downstream of Copco No. 2 Dam in a lava rockslide (no documentation date) (2017a).
Tehama chaparral *Trilobopsis tehamana*	--/--/FSS, BLMS	Rocky talus and under leaf litter or woody debris within approximately 330 feet of limestone outcrops	• Two occurrences in 1990 and 1994—one sighting near the Klamath River and another along the hill slope. Both occurrences are more 20 RM downstream of Iron Gate Dam (2017a).
Western bumblebee *Bombus occidentalis*	–/–/FSS	Shrub, chaparral, and open grassy areas (urban parks, mountain meadows)	• Six sightings from 1969 and earlier are located more than 70 RM downstream of Iron Gate Dam (2017a).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Amphibians			
Southern torrent (southern seep) salamander *Rhyacotriton variegatus*	–/SSC/FSS	In and adjacent to cold, permanent, well-shaded mountain springs, waterfalls, and seeps with rock substrate	• Not observed in California during the PacifiCorp surveys (PacifiCorp 2004a). • Approximately 10 sightings have been recorded, approximately 50 RM or more downstream from Iron Gate Dam typically along tributaries or at the confluence to the Klamath River; the most recent sighting was from 2007. • Found to be widespread in the tributaries of the Lower Klamath River (Green Diamond Resources Company 2006), but due to lack of suitable habitat, would not be expected to occur in the mainstem of the Lower Klamath River.
Scott Bar salamander *Plethodon asupak*	--/ST/--	Rocky forested areas, especially thick moss-covered talus; elevation range of 1,500–2,000 feet	• Not documented in California during the PacifiCorp surveys (PacifiCorp 2004a,b). • Documented at four locations approximately 30 RM downstream of Iron Gate Dam between 1996 and 2005 (CDFW 2017a).
Siskiyou Mountains salamander *Plethodon stormi*	--/ST/FSS	Loose rock talus on north-facing slopes or in dense wooded areas; also under bark near talus	• Not documented in California during the PacifiCorp surveys (PacifiCorp 2004a). • Documented at five locations approximately 30 RM downstream of Iron Gate Dam between 1972 and 2003 (CDFW 2017a).
Pacific tailed frog *Ascaphus truei*	–/SSC/–	In and adjacent to cold, clear, moderate- to fast-flowing, perennial mountain streams in conifer forest	• Not documented in California during the PacifiCorp surveys (PacifiCorp 2004a). • Observed at the confluence of a tributary approximately 60 RM downstream from Iron Gate Dam in 1989. Farther downstream, five additional sites are documented along tributaries to the Klamath or at the confluence (2017a). • Found to be widespread in the tributaries of the Lower Klamath River (Green Diamond Resources Company 2006), but due to lack of suitable habitat for these species, would not would be expected to occur in the mainstem of the Lower Klamath River.

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Foothill yellow-legged frog *Rana boylii*	Petition to list/ SCT, SSC/FSS, BLMS	Shallow tributaries and mainstems of perennial streams and rivers, typically associated with cobble or boulder substrate	• Documented on tributaries to the Klamath River (CDFW 2017a). • Documented in 2017 on the Lower Klamath River, approximately 13 RM upstream of the estuary (M. Wikaira Yurok Tribe to Parker Thaler, pers. comm., January 2018), approximately 20 RM upstream of the estuary by landowner Green Diamond in 1994 (CDFW 2017a), and approximately 50 RM downstream from Iron Gate Dam in 1970 and farther downstream in 1976 (CDFW 2017a). • Detections are rare in the Klamath Basin (AmphibiaWeb 2017) • PacifiCorp targeted surveys in 2003 at most likely habitat locations (including Bogus and Cottonwood Creek, approximately 0.2 and 7 miles downstream of Iron Gate Dam, respectively) detect no occurrences (PacifiCorp 2004a). • Historical localities were restricted to a relatively small area that consisted of the mainstem Klamath River in the Klamath River Canyon, California, and its nearby tributaries (Borisenko and Hayes 1999). • One frog observed at Boise Creek in 1999 (Hayes et al. 2016).
Northern red-legged frog *Rana aurora*	–/SSC/FSS	Breeds in still or slow-moving water with emergent and overhanging vegetation, including wetlands, wet meadows, ponds, lakes, and low-gradient, slow-moving stream reaches with permanent pools; uses adjacent uplands for dispersal and summer retreat	• Not documented in California during the PacifiCorp surveys (PacifiCorp 2004a). • A 1995 sighting was documented approximately 20 RM upstream of the Klamath River Estuary; species located along the north bank of the Klamath River along mats of vegetation (CDFW 2017a).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Reptiles			
Western pond turtle *Actinemys marmorata*	Petition to list/SSC/FSS, BLMS	Permanent, slow-moving fresh or brackish water with available basking sites and adjacent open habitats or forest for nesting	• Documented in 2018 at Iron Gate Reservoir with majority of observations along the northern half of the reservoir (Mirror Cove and near Camp Creek and Jenny Creek) and throughout Copco No. 1 Reservoir with majority of observations occurring in the northern Beaver Creek and Raymond Gulch coves. Also observed near the Copco Rd bridge at the upstream end of the reservoir (CDM Smith 2018c). • Considered common to abundant in many Lower Klamath Project reservoirs and reaches with suitable nesting habitat being present. During PacifiCorp 2002 and 2003 surveys, 6 turtles were documented in California portion of the J.C. Boyle peaking reach (12 at Copco No. 1 Reservoir, 18 in the beaver dam pond/wetland between Fall Creek and Iron Gate Reservoir, and 17 at Iron Gate Reservoir. Surveys downstream of the Iron Gate Dam to Shasta River documented one site with 9 turtles; however, it was noted that the survey had several gaps due to sites being inaccessible (PacifiCorp 2004a). • Documented basking during May 2018 wildlife surveys in the reservoirs-9 in Iron Gate Reservoir and between 31-36 in Copco No. 1 Reservoir (K. Stenberg, Principal, CDM Smith, pers. comm., July 2018). • Approximately 10 miles RM downstream of Iron Gate Dam, an individual was observed basking approximately 0.5 miles upstream of Williams Creek at the confluence of a tributary in November 2005 (CDFW 2017a).PacifiCorp (2002) indicated that most basking probably occurs in Iron Gate Reservoir when water levels decrease, and the turtles use emerging rocks and boulders; however low water levels reduce the amount of aquatic habitat and make bordering emergent wetlands less accessible due to increased distance (PacifiCorp 2004a).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Northern sagebrush lizard *Sceloporus graciosus*	–/–/BLMS	Inhabits sagebrush, chaparral, juniper woodlands, and dry conifer forests	• Documented during PacifiCorp surveys near the edge of a forested wetland along Iron Gate Reservoir (PacifiCorp 2004a). • Documented during 2018 surveys in several areas surrounding Copco No. 1 Reservoir including a large population in a rocky area to the east of Fall Creek, and Iron Gate Reservoir including Bogus Creek fish hatchery, Long Gulch Cove shoreline, Jenny Creek shorelines, and recreational areas (CDM Smith 2018c,d).
Birds			
American white pelican *Pelecanus erythrorhynchos*	–/SSC/–	Nests at lakes and marshes and uses almost any lake outside of the breeding season	• Documented during PacifiCorp surveys—55 pelicans on Copco No. 1 Reservoir and 107 pelicans on Iron Gate Reservoir (PacifiCorp 2004a). • Documented at Copco No. 1 and Iron Gate reservoirs (eBird 2018), • Documented during 2018 surveys throughout Copco No. 1 Reservoir near the dam and in Keaton Cove and at Iron Gate Reservoir, including Mirror Cove, Juniper Point, upstream extent of the reservoir, and near the boom in front of Iron Gate Dam (CDM Smith 2018c,d).
Barrow's goldeneye *Bucephala islandica*	–/SSC/–	May be found in northern California during the winter (non-breeding season) along open water and riverine habitat. Nests in cavities, including artificial nest boxes	• Documented during PacifiCorp surveys at Copco and Iron Gate reservoirs primarily between January and April (PacifiCorp 2004a), prior to northward migration. • Documented at Iron Gate Reservoir and on the Klamath River downstream of Iron Gate Dam (eBird 2018).
Common loon *Gavia immer*	–/SSC/–	Freshwater lakes, rivers, estuaries, and coastlines	• Documented during PacifiCorp surveys at Iron Gate Reservoir (PacifiCorp 2004a).
Bald eagle *Haliaeetus leucocephalus*	–, Bald and Golden Eagle Protection Act (BGEPA), SFP/SE, BLMS, FSS	Large bodies of water or rivers with abundant fish; uses adjacent snags or other perches; nests and winter communal roosts in advanced-successional conifer forest within approximately 1 mile of open water	• Documented during the KRRC surveys, two inactive bald eagle nests—one within 0.5 miles of Copco Reservoir and one located between 0.5–2 miles of Iron Gate Reservoir (S. Leonard, AECOM, Senior Water Resources Engineer, pers. comm, October 2018). • Documented in 1997 along the Klamath River, and approximately 2 miles from Copco No. 1 and No. 2 dams (CDFW 2017a). • Documented during PacifiCorp surveys at J.C. Boyle and Copco No. 1 reservoirs. The highest number of bald eagles (12) was found at Copco No.1 Reservoir (PacifiCorp 2004a,b).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Northern harrier *Circus cyaneus*	–/SSC/–	Nests, forages, and roosts in wetlands or along rivers or lakes, but also in grasslands, meadows, or grain fields	• Documented during PacifiCorp surveys along the Klamath River from Iron Gate Dam to Shasta River (PacifiCorp 2004a). • Documented along Copco No. 1 Reservoir, along Iron Gate Reservoir and tributaries, and Klamath River downstream of Iron Gate Dam (eBird 2018).
Northern goshawk *Accipter gentilis*	–/SSC/FSS, BLMS	Mature and old-growth stands of coniferous forest, middle and higher elevations; nests in dense part of stands near an opening	• Documented during PacifiCorp surveys flying over J.C. Boyle peaking reach (PacifiCorp 2004a). • Documented in 1981 more than 80 RM downstream of Iron Gate Dam (CDFW 2017a).
Swainson's hawk *Buteo swainsoni*	–/ST/BLMS	Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, and grain fields	• Documented occurrences within the Project Vicinity near agricultural fields approximately 10 miles east of Copco No. 1 Reservoir (CDFW 2017a).
Golden eagle *Aquila chrysaetos*	–/SFP/–	Open woodlands and oak savannahs, grasslands, chaparral, sagebrush flats; nests on steep cliffs or large trees	• Documented during PacifiCorp surveys along the lower reaches of the J.C. Boyle peaking reach and along Iron Gate and Copco No. 1 reservoirs (PacifiCorp 2004a). • Also documented along the Klamath River, downstream of Iron Gate Dam (eBird 2018). • Two active golden eagle nests were documented during the KRRC surveys within two miles of Copco No. 1 Reservoir and three inactive nests were documented within 2 miles of Iron Gate Reservoir (S. Leonard, AECOM, Senior Water Resources Engineer, pers. comm, October 2018). In May 2018, a golden eagle was observed at Copco No. 1 Reservoir perched on a slope on the northern shoreline, a pair was observed near a northern cove, and one was observed bathing in the shallow water (CDM Smith 2018c).
American peregrine falcon *Falco peregrinus*	–/SFP/–	Wetlands, woodlands, cities, agricultural lands, and coastal area with cliffs (and rarely broken-top, predominant trees) for nesting; often forages near water	• Documented around Iron Gate Reservoir (CDFW 2017a). • Documented of Iron Gate Dam along the Klamath River (eBird 2018).
Greater sandhill crane *Grus canadensis tabida*	–/ST, SFP/FSS, BLMS	Forages in freshwater marshes and grasslands as well as harvested rice fields, corn stubble, barley, and newly planted grain fields	• Documented nesting habitat at J.C. Boyle Reservoir in May 2018 (Appendix B: *Definite Plan – Appendix J*). • Documented during the PacifiCorp surveys at J C. Boyle Reservoir (PacifiCorp 2004a). Other sightings in ponds and near agricultural fields east of Yreka (CDFW 2017a).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Black tern *Chlidonias niger*	–/SSC/–	Nests semi-colonially in protected areas of marshes	• Documented during PacifiCorp surveys at J.C. Boyle Reservoir (PacifiCorp 2004a).
Western yellow-billed cuckoo *Coccyzus americanus*	FT/SE/FSS, BLMS No critical habitat proposed within the Primary Area of Analysis	Summer resident of valley foothill and desert riparian habitats; nests in open woodland with clearings and low, dense, scrubby vegetation	• Although not documented in the area, it has been noted that the species has the potential to be in the vicinity (PacifiCorp 2004a). • In coordination with state agencies, it has been noted that breeding habitat is unlikely in the area.
Northern spotted owl *Strix occidentalis caurina*	FT/ST, SSC/– Critical habitat designated approximately 0.5 miles south east of Copco No. 1 Reservoir	Typically in older forested habitats; nests in complex stands dominated by conifers, especially coastal redwood, with hardwood understories; some open areas are important for foraging	• Detected during PacifiCorp surveys southeast of Copco No. 1 Reservoir (PacifiCorp 2004a). • Activity center is located approximately 1.7 miles southeast of Copco No. 1 Reservoir (CDFW 2017c). • Designated critical habitat approximately 0.5 miles southeast of Copco No. 1 Reservoir and along the Klamath River approximately 40 RM downstream of Iron Gate Dam. • Critical habitat is located north of the Lower Klamath Project in the Jenny Creek basin, upstream of Copco No. 1 Reservoir, and along portions of the Lower Klamath River. Also documented on National Forest lands and along the Lower Klamath River on lands managed by Green Diamond Resources Company.
Great gray owl *Strix nebulosi*	–/SE/FSS	Dense, coniferous forest, usually near a meadow for foraging; nests in large, broken-topped snags	• Documented during PacifiCorp surveys east of Fall Creek near Jenny Creek (PacifiCorp 2004a).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Black swift *Cypseloides niger*	–/SSC/–	Nests in moist crevices behind or beside permanent or semi-permanent waterfalls in deep canyons, on perpendicular sea cliffs above surf, and in sea caves; forages widely over many habitats	• Not documented in California during the PacifiCorp surveys (PacifiCorp 2004a). • Single occurrence is known from 1982 along the banks of the Klamath River, over 100 RM downstream of Iron Gate Dam (CDFW 2017a).
Vaux's swift *Chaetura vauxi*	–/SSC/–	Redwood and Douglas-fir habitats with large snags, especially forest with larger basal hollows and chimney trees	• Documented during PacifiCorp surveys at Copco No. 1 and Iron Gate reservoirs, along the J.C. Boyle peaking reaches, along Fall Creek, and along Klamath River from Iron Gate Dam to Shasta River (PacifiCorp 2004a).
Black-backed woodpecker *Picoides arcticus*	Petitioned for listing filed in 2012. In October 2017, USFWS released a finding indicating listing of the species is not warranted (USFWS 2017b)/ Petitioned for listing filed in 2012. In May 2013, the Fish and Game Commission released a finding indicating listing of the species is not warranted (CDFW 2013)/–/–	Affinity to boreal and montane coniferous forests post-burn or following outbreaks of wood-burning beetles	• Not documented in the area; however, potential for the species to occur due to the presence of suitable habitat (coniferous forest).
Olive-sided flycatcher *Contopus cooperi*	–/SSC/–	Primarily advanced-successional conifer forests with open canopies	• Documented during PacifiCorp surveys along Iron Gate Reservoir and along J.C. Boyle peaking reach (PacifiCorp 2004a). • Observed during 2018 surveys at the northern coves and riparian woodlands at Copco No. 1 Reservoir (CDM Smith 2018c)

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Willow flycatcher *Empidonax traillii*	–/SE/FSS	Dense brushy thickets within riparian woodland often dominated by willows and/or alder, near permanent standing water; uses brushy, early-succession forests (e.g., clearcuts) in the Pacific Northwest	• Documented during PacifiCorp surveys in riparian and wetland habitats located along the shoreline of Copco No. 1 and Iron Gate reservoirs, along the J.C. Boyle peaking reach, and along Klamath River from Iron Gate Dam to Shasta River (PacifiCorp 2004a). • Documented Iron Gate Reservoir at Jenny Creek in 2008 (CDFW 2017a). • Observed during 2018 surveys at Copco No. 1 Reservoir in the northern cove at the confluence of West Fork Beaver Creek, Beaver Creek, and East Fork Beaver Creek in fringe willow (CDM Smith 2018c).
Purple martin *Progne subis*	–/SSC/–	Conifer, valley-foothill, montane-hardwood forests with large snags in open areas; most nest sites located in upper slopes of hilly terrain; also may nest in human-made structures with cavities	• Documented during PacifiCorp surveys upstream of the upper falls at Fall Creek (PacifiCorp 2004a). • Documented a few locations along the Klamath River, downstream of Iron Gate Dam (eBird 2018).Observed nesting during 2018 survey on a utility pole near the intersection of Copco Road and the dam access spur road (CDM Smith 2018c).
tricolored blackbird *Agelaius tricolor*	Petition to list/SCE, SSC/–	Feeds in grasslands and agriculture fields; nesting habitat components include open accessible water, a protected nesting substrate (including flooded or thorny vegetation), and a suitable nearby foraging space with adequate insect prey	• A single sighting in 2011 (eBird 2018) at Copco No. 1 Reservoir and potential for the species to occur due to the potential presence of suitable habitat (open foraging area adjacent to aquatic habitat). • Flock of approximately 25 observed in an agricultural field along Yreka Ager Road, located approximately 12 miles southwest of the Bogus Creek Fish Hatchery (CDM Smith 2018c).
Yellow warbler *Setophaga petechia*	–/SSC/–	Open-canopy, deciduous riparian woodland close to water, along streams or wet meadows	• Documented during PacifiCorp surveys at all Lower Klamath Project reservoirs and reaches (PacifiCorp 2004a). • Documented along the Klamath River downstream of Iron Gate Dam (eBird 2018). • Observed around Copco No. 1. Reservoir and most frequent in riparian woodlands and hillside seep areas and also at Iron Gate Reservoir, including Bogus Creek fish hatchery, Brush Creek, Camp Creek, and Jenny Creek (CDM Smith 2018c).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Yellow-breasted chat *Icteria virens*	–/SSC/–	Early-successional riparian habitats with a dense shrub layer and an open canopy	• Documented during PacifiCorp surveys in wetland and riparian habitats along J.C. Boyle peaking reach, at Copco No. 1 Reservoir, along Fall Creek, and along Klamath River from Iron Gate Dam to Shasta River (PacifiCorp 2004a). • Documented during 2018 surveys in the northern cove of Iron Gate Reservoir near Camp Creek and Horseshoe Ranch Wildlife Area, and at Fall Creek and along the southern portion of Copco No. 1 Reservoir, near Ager Beswick Road east of Keaton Cove (CDM Smith 2018c).
Mammals			
Western mastiff bat *Eumops perotis californicus*	–/SSC/–	Variety of habitats including desert scrub, chaparral, oak woodland, ponderosa pine, mid-elevation conifer (e.g., giant sequoia). Roosting habitat mostly associated with significant rock features. Forages seasonally at high elevations	• Not documented in California during PacifiCorp surveys (PacifiCorp 2004a). • Documented at Medicine Lake, Siskiyou County (Pierson and Rainey 1998). • Range includes the Primary Area of Analysis (CDFG 1997).
Townsend's western big-eared bat *Corynorhinus townsendii*	–/SSC/FSS, BLMS	Roosts in cavities, usually tunnels, caves, buildings, and mines, but also rock shelters, preferentially close to water. Caves near water's edge are favored.	• Not documented in California during the PacifiCorp surveys (PacifiCorp 2004a). • Two documented occurrences in 1997 at bridges approximately 40 RM downstream of Iron Gate Dam (CDFW 2017a). • Suitable habitat (e.g., man-made structures) are present in the Limits of Work. Structures providing habitat for a non-special-status bat species (Yuma myotis) were documented at the Copco No. 1 powerhouse and the Iron Gate south gatehouse (PacifiCorp 2004a), which may support other bat species.
Spotted bat *Euderma maculatum*	–/SSC/BLMS	Roosts in cracks, crevices, and caves, usually high in fractured rock cliffs solitary or in small groups	• Suitable habitat for this species (e.g., large dam faces) may be present in the Limits of Work. • Although not documented during PacifiCorp roost surveys, species speculated to be rare, but widely distributed, and as a result may be in Area of Analysis (PacifiCrop 2004a).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Pallid bat *Antrozous pallidus*	–/SSC/FSS, BLMS	Roosts in rock crevices, live or dead tree hollows, mines, caves, and a variety of vacant and occupied structures or buildings	• Not documented in California during PacifiCorp surveys (PacifiCorp 2004a); however, it was noted that species presence of a roost site was documented by one dead individual (Yuma myotis), and that it is possible that sites with confirmed evidence of bat use support aggregations of more than one species. • No CNDDB occurrences are documented within the Primary Area of Analysis. • Suitable habitat are present in the Limits of Work. Structures providing habitat for a non-special-status bat species (Yuma myotis) were documented at the Copco No. 1 powerhouse and the Iron Gate south gatehouse (PacifiCorp 2004a), which, along with other structures, trees, rock crevices in the area, may support other bat species.
Fringed myotis *Myotis thysanodes*	–/–/BLMS, FSS	Roosts in crevices, cavities, and foliage in a wide variety of habitats including rock crevices, caves, mines, buildings and bridges, and large-diameter snags	• Not documented in California during PacifiCorp surveys; however, it was noted that species presence of a roost site was documented by one dead individual (*Yuma myotis*), and that it is possible that sites with confirmed evidence of bat use support aggregations of more than one species. (PacifiCorp 2004a). • No CNDDB occurrences are documented within the Primary Area of Analysis. • Suitable habitat are present in the Limits of Work. Structures providing habitat for Yuma myotis were documented at the Copco No. 1 powerhouse and the Iron Gate south gatehouse (PacifiCorp 2004a), which, along with other structures, trees, rock crevices in the area, may support other bat species. • Habitat for myotis species inside Copco No. 1 C-12 gate house as a maternity roost of more than 2,000 Myotis spp. (species not noted) was confirmed in June 2018 and several hundred bats (species not noted) also roosting at Copco 1 diversion tunnel and Iron Gate diversion tunnel (KRRC 2018b).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
Long-eared myotis (*Myotis evotis*)	–/–/BLMS	Roosts in bridges, buildings, under exfoliating tree bark, and in hollow trees, caves, mines, cliff crevices, sinkholes, rocky outcrops on the ground	• Not documented in California during PacifiCorp surveys; however, it was noted that species presence of a roost site was documented by one dead individual (Yuma myotis), and that it is possible that sites with confirmed evidence of bat use support aggregations of more than one species. (PacifiCorp 2004a). • Suitable habitat (e.g., man-made structures) are present in the Limits of Work. • Habitat for myotis species inside Copco No. 1 C-12 gate house as a maternity roost of more than 2,000 Myotis spp. (species not noted) was confirmed in June 2018 and several hundred bats (species not noted) also roosting at Copco 1 diversion tunnel and Iron Gate diversion tunnel (KRRC 2018b).
Yuma myotis *Myotis yumanensis*	–/–/BLMS	Roosts in bridges, buildings, cliff crevices, caves, mines, and trees	• Structures providing habitat for Yuma myotis were documented at the Copco No. 1 powerhouse and the Iron Gate south gatehouse (PacifiCorp 2004a). • Habitat for myotis species inside Copco No. 1 C-12 gate house as a maternity roost of more than 2,000 Myotis spp. (species not noted) was confirmed in June 2018 and several hundred bats (species not noted) also roosting at Copco 1 diversion tunnel and Iron Gate diversion tunnel (KRRC 2018b).
Gray wolf *Canis lupus*	FE/SE/– No critical habitat designated	Range of habitats including temperate forests, mountains, tundra, taiga, and grasslands	• The Lower Klamath Project is not within or near the area of current wolf activity; however, have been previously documented in the area (CDFW 2017a; M. Harris, Senior Environmental Scientist, CDFW, pers. comm., October 2017). • Since December 2011, at least two packs of gray wolves and three separate individual wolves have been detected in California. Key wolf use areas to date have included western Lassen and eastern Siskiyou counties, although wolves have also been known to utilize parts of Modoc, Plumas, Shasta, and Tehama counties (M. Harris, Senior Environmental Scientist, CDFW, pers. comm., November 2017).

Common Name Scientific Name	Status[a] Federal/ State/USDA Forest Service, BLM	Habitat Association	Available Habitat and Occurrence Information within the Primary Area of Analysis
American badger *Taxidea taxus*	–/SSC/–	Shrubland, open grasslands, fields, and alpine meadows with friable soils	• Not documented in California during PacifiCorp surveys (PacifiCorp 2004a). • A single occurrence (unknown date) was documented approximately 2 miles upstream of Copco No. 1 Reservoir (CDFW 2017a).

[a] Status codes:

Federal
FT = Listed as threatened under the federal Endangered Species Act
BGEPA = Federally protected under the Bald and Golden Eagle Protection Act
FSS = USDA Forest Service Sensitive species
BLMS = Bureau of Land Management Sensitive Species

State
SE = Listed as Endangered under the California Endangered Species Act
ST = Listed as Threatened under the California Endangered Species Act
SCT = State Candidate Threatened
SSC = CDFW Species of Special Concern
SFP = CDFW Fully Protected species

3.5.2.6 Wildlife Corridors and Habitat Connectivity

Project reservoirs and waterways create substantial breaks in the connectivity of riparian habitat. Large mammals such as elk and deer are likely able to traverse narrow reservoirs, while these waterways may create barriers to small mammals, reptiles, and amphibians. In addition, canals, roads, powerhouses, and other facilities can block movement of amphibians and reptiles (PacifiCorp 2004a).

Riparian corridors facilitate dispersal of both aquatic and terrestrial wildlife. Riparian areas provide shade, cooler temperatures, and substrate for cover, breeding, or foraging for amphibians such as western toads and many bird species such as western yellow-billed cuckoo and yellow-breasted chat. Continuous riparian connectivity plays an important role during dispersal of juvenile birds, and reservoirs may support dispersal of juvenile birds in some areas (PacifiCorp 2004a).

Transmission power lines have the potential to cause bird mortality from collisions, particularly when transmission lines cross flight paths that birds use during seasonal migration or daily movements between foraging and nesting areas. PacifiCorp assessed transmission line configurations for raptor-safe design by evaluating electrocution and collision hazards relative to standards and guidelines for power lines described in the Edison Electric Institute’s publications, Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996 (APLIC 1996) and Mitigating Bird Collisions with Power Lines: The State of the Art in 1994 (APLIC 1994) (PacifiCorp 2004a). PacifiCorp determined that there are three segments of transmission lines in California near areas of high waterfowl and wading bird use: one segment near the upstream end of Iron Gate Reservoir and two segments that cross Iron Gate Reservoir. The probability of avian collision is reduced at these sites as the lines do not pass between the reservoirs, rivers, major wetlands, or cropland that would attract foraging birds. Based on the date of this writing, no collisions or electrocutions have been documented by PacifiCorp personnel for any of the FERC Project-related transmission lines since a Memorandum of Understanding to document bird mortalities was filed in the 1980s between PacifiCorp and CDFW, ODFW, and USFWS (PacifiCorp 2004a).

3.5.3 Significance Criteria

Criteria for determining significant impacts on terrestrial resources are based upon Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and professional judgment informed by best available data. Effects on terrestrial resources are considered significant if the Proposed Project would:

- Result in population-level impacts on state species of special concern, USDA Forest Service sensitive wildlife species on USDA Forest Service lands, or BLM sensitive species on BLM lands.

- Result in any of the following to the other types of special-status species[112]: not listed above: direct mortality or physical harm to individuals; degradation of habitat or a change in habitat conditions that would result in physiological impairment or that may affect the ability to perform essential behaviors such as migration, feeding, or reproducing; or abandonment of active bird nests or hibernacula or maternity bat roosts due to noise or structure removal (i.e., buildings, vegetation).
- Result in substantial removal or degradation of any riparian habitat or rare natural community.
- Result in substantial modifications of federally protected wetlands as defined by Section 404 of the Clean Water Act through direct removal, filling, hydrological interruption, or other means.
- Result in population-level impacts to culturally significant plant species, or a substantial change in habitat conditions that support these plants.
- Result in a substantial reduction of acreage or degradation of habitat that supports rare natural communities, for instance, through the introduction or spread of invasive plants.
- Result in substantial interference with the movement of any native resident or migratory wildlife species or with documented native resident or migratory wildlife corridors.
- Conflict with any local policies protecting biological resources, such as a tree preservation policy, where the conflict would result in an adverse impact on terrestrial resources.
- Conflict with the provisions of an adopted Habitat Conservation Plan (HCP), Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan, where the conflict would result in an adverse impact on terrestrial resources.

3.5.4 Impact Analysis Approach

The impact analysis focused on the Primary Area of Analysis for terrestrial resources (area surrounding the Limits of Work and Klamath River downstream to the Pacific Ocean [see Section 3.5.1 *Area of Analysis*]). Property within the Secondary Area of Analysis for terrestrial resources would eventually be transferred to the respective states (i.e., California or Oregon) and managed for public interests (e.g., creation of open space, wetland and riverine restoration, river-based recreation, and grazing). Given that future land uses are speculative and potential impacts will vary, potential impacts to the Secondary Area of Analysis are not analyzed in this section. However, since the vegetation types, geology, climate, and hydrology of the Secondary Area of Analysis are similar to the Primary Area of Analysis, potential impacts from ground and noise

[112] Based on coordination with CDFW, significant impacts would occur if there is direct mortality or physical harm to special-status species which are defined as those species listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA); those designated by the USDA Forest Service as sensitive or watch list species; those listed as rare under the California Native Plant Protection Act and/or included on CDFW's most recent *Special Vascular Plants, Bryophytes, and Lichens List* with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4 (CDFW 2017a); those designated as a Species of Special Concern by CDFW, designated as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515), and/or protected under the federal Bald and Golden Eagle Protection Act.

disturbance activities (e.g., wetland and riverine restoration activities, recreation activities) in the Secondary Area of Analysis are expected to be similar to those in the Primary Area of Analysis.

Evaluation of the Proposed Project considered both short- and long-term effects on terrestrial resources. Short-term effects were defined as impacts that have the potential to occur within two years of the action and long-term effects were defined as impacts that have the potential to occur two years or more after the activity is completed. The analysis considered the timing of the action as identified in Appendix H of the Definite Plan (e.g., pre-dam removal period [one to two years prior to drawdown], reservoir drawdown period [January to March, year of drawdown], dam removal period [spring, summer, and fall immediately after drawdown], post-dam removal period [after dam removal is complete], plant establishment period [Year 1], and maintenance and monitoring period [Years 2 to 5]). Short-term impacts on nesting birds were evaluated as a result of construction-related noise greater than ambient conditions, and species-specific noise impacts on northern spotted owl were assessed for a 1-mile buffer around all dams to account for the loudest noise disturbance distance associated with blasting, 0.5-mile buffer around all reservoirs to account for the loudest noise disturbance distance associated with helicopter use, and 0.25-mile buffer around all other areas within the Limits of Work to account for noise disturbance associated with heavy equipment. These northern spotted owl noise disturbance distances were developed in coordination with the Arcata USFWS office based on an estimation of auditory and visual disturbance effects (USFWS 2006).

There are some terrestrial species (amphibians, reptiles) that have an aquatic life history aspect in riverine habitats (river and on river banks) and thus impacts from flow and sediment were also evaluated. Outputs of sediment transport and hydrologic models were used to predict modifications to terrestrial vegetation communities and how those would affect riparian zones, wetlands, and aquatic habitats, as well as special-status wildlife and plant species. Additional information on hydrologic modeling is provided in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*. The terrestrial resources analysis also incorporated impacts due to upland habitat modification during construction (e.g., staging areas).

There are terrestrial special-status species that may inhabit upland habitat (plants, invertebrates, birds, mammals) along the Middle Klamath River, Lower Klamath River, and Klamath River Estuary. As discussed in Section 3.6 *Flood Hydrology*, anticipated flow rates would stay below historical peak flows and would not alter the 100-year floodplain in the Middle Klamath River downstream of Humbug Creek. Therefore, flow-related impacts on terrestrial upland species would be similar to those under existing conditions and are not analyzed further.

The evaluation of potential impacts on terrestrial resources due to the Proposed Project included development of measures to reduce significant impacts to the extent feasible. Where the State Water Board can implement the measures, they are analyzed as mitigation measures. In some cases, implementation of such terrestrial resources measures would be not be considered feasible for the purposes of CEQA because the State Water Board cannot ensure that they would occur. In these cases, recommended measures are provided that would reduce potential impacts if implemented by KRRC. However, the impact analysis herein does not rely on the implementation of these measures. Both the terrestrial resources mitigation measures and the recommended measures are consistent with widely accepted professional best management practices for environmental protection and many of the measures were developed in consultation with CDFW and USFWS. In other cases, there are mitigation measures the State Water Board can ensure through the water quality certification. In these cases, the mitigation measure is considered as part of the impact analysis and determination of significance.

The following sources were assessed to determine the scope of existing local policies relevant to the Proposed Project:

- Del Norte County General Plan (Mintier & Associates et al. 2003):
  - Section 1 (Natural Resources/Conservation), Wildlife Habitat Resources, Policies 1.E.1, 1.E.2, 1.E.8, 1.E.9, 1.E.11, 1.E.12, 1.E.28, 1.E.29 and 1.E.33
- Humboldt County General Plan for Areas Outside of the Coastal Zone (Humboldt County 2017):
  - Conservation and Open Space Element, Biological Resources Policies BR-P7, BR-P9, BR-P10, and BR-P12
- Klamath County Comprehensive Plan (Klamath County 2010):
  - Goal 5 (Open Space, Scenic, and Historic Area and Natural Resources), Policies 3, 4, 10, 11, 12, and 16
- Siskiyou County General Plan (Siskiyou County 1980):
  - Deer Wintering Area Policies 28 and 29 (Siskiyou County n.d.)
  - The Conservation Element (Siskiyou County 1973), Wildlife Habitat, Objectives 1, 5–8

Most of the aforementioned policies (and objectives) are stated in generalized terms, consistent with their overall intent to protect terrestrial resources, including special-status wildlife and plant species as well as wetland, riparian, and rare natural communities. By focusing on the potential for impacts to specific special-status wildlife and plant species, as well as defined wetland, riparian, and rare natural communities within the terrestrial resources Area of Analysis, consideration of the more general local policies listed above is inherently addressed by the specific, individual analyses presented in Section 3.5.5 *[Aquatic Resources] Potential Impacts and Mitigation*. A subset of the existing local policies listed above contain more detailed information, including Del Norte County's General Plan Policy 1.E.29, which requires on-site mitigation for impacts on riparian vegetation, and Humboldt County's General Plan Policy BR-P9, which requires that oak mitigation be consistent with the provisions of CEQA, specifically Public Resources Code Section 21083.4. Del Norte County's General Plan Policy 1.E.29 is consistent with the Proposed Project actions regarding riparian vegetation (i.e., Reservoir Area Management Plan [Appendix B: *Definite Plan – Appendix H*]). The areas where there may be an impact on oaks due to Proposed Project construction activities (i.e., Limits of Work plus a 0.25-mile buffer, see also Section 3.5.1 *Area of Analysis*) are not within Humboldt County, so there would be no conflict with Humboldt County's General Plan Policy BR-P9.

The following sources were assessed to determine the scope of existing HCPs relevant to the Proposed Project and potential for overlap with the Primary Area of Analysis for Terrestrial Resources: (a) PacifiCorp's Interim Operations Habitat Conservation Plan for the Klamath Hydroelectric Project (PacifiCorp 2012) and (b) Green Diamond Forest

Habitat Conservation Plan (Green Diamond Resource Company 2018). These HCPs also provide generalized terms for protection of terrestrial resources, including special-status wildlife and plant species as well as wetland, riparian, and rare natural communities. By focusing on the potential for impacts to specific special-status wildlife and plant species, as well as defined wetland, riparian, and rare natural communities within the terrestrial resources Area of Analysis, the specific, individual analyses presented in Section 3.5.5 *[Aquatic Resources] Potential Impacts and Mitigation* address the HCPs.

3.5.5 Potential Impacts and Mitigation

3.5.5.1 Vegetation Communities

Potential Impact 3.5-1 Construction-related impacts on wetland and riparian vegetation communities.

Disturbances associated with construction areas, disposal sites, and haul roads where clearing, grading, and staging of equipment would occur could have short-term impacts on sensitive habitats, including wetlands and riparian habitats along reservoirs and river reaches. Heavy machinery traversing wetland and riparian areas could change local topography and impact wetland and riparian vegetation and could introduce increased levels of dust and runoff pollution to wetland and riparian areas that could degrade plant community conditions. Several of the bridges required for access to and from the dam sites would be replaced or upgraded prior to reservoir drawdown (see Potential Impact 3.22-2). Adjacent riparian vegetation under or adjacent to the existing or new bridges could be impacted during these activities. Additionally, removal of recreation sites could result in impacts on wetland and riparian vegetation (e.g., the Palustrine Forested Wetland at Iron Gate Reservoir). Wetland and riparian vegetation are likely to be present in the areas where construction activities are planned to occur; without surveys to document these habitats and measures to adequately protect them, these habitats would be likely to be degraded or removed and thus construction-related activities would result in a significant short-term impact.

Based on existing data for the Primary Area of Analysis for terrestrial resources (Section 3.5.2.1 *Vegetation Communities*), wetland and riparian habitats (Estuarine, Montane Riparian, Palustrine, and Wet Meadow) account for approximately five percent of the total acreage. The Proposed Project identifies a number of pre-construction measures to reduce impacts on these habitats. First, a wetland delineation would be conducted within the limits of construction around the dams and facilities, access and haul roads, and disposal sites in accordance with the 1987 USACE Wetland Delineation Manual (USACE 1987) and applicable Regional Supplements (i.e., Western Mountains, Valleys, and Coast Region [USACE 2010] and Arid West [USACE 2008]). The results of the wetland delineation would be incorporated into the Proposed Project design to avoid and minimize direct impacts on wetlands to the maximum extent feasible, and wetland areas adjacent to the construction Limits of Work would be fenced to prevent inadvertent entry. There could be impacts on wetlands if the fencing does not include an appropriate buffer (i.e., a prescribed distance from the edge of the wetland in which construction activities are prohibited); however, with implementation of Mitigation Measure TER-1, short and long-term impacts on wetland communities would be reduced to less than significant.

Additionally, the Proposed Project includes construction best management practices (Appendix B: *Definite Plan – Appendix J*) to reduce potential impacts on water quality in wetlands and other survey waters during construction. The combination of these measures and implementation of Mitigation Measure WQ-1, as described in Potential Impact 3.2-4, would reduce potential impacts on wetlands to less than significant.

The Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) includes details for the installation of native plants and aerial, barge, or hand seeding in appropriate areas to re-vegetate all areas disturbed during construction, including reservoir areas, demolition and disposal sites, staging, access and haul roads, and turn-arounds, with a goal of no net loss of wetland or riparian habitat acreage and functions. Wetlands established in restored areas would be monitored for five years or until the performance criteria (as defined in Appendix B: *Definite Plan – Appendix H*, Section 6.1.4) have been met. To minimize the introduction of invasive plant species into construction areas, construction vehicles and equipment would be cleaned with compressed water or air within a designated containment area to remove pathogens, invasive plant seeds, or plant parts, and disposed of in appropriate disposal facilities. The Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) also includes a five-year monitoring plan with metrics to evaluate success of minimizing invasive exotic vegetation (i.e., percent relative cover by medium and low priority invasive plants [as defined in the Reservoir Area Management Plan] shall be less than the average at designated reference locations as follows: 25 percent in Year 1; 40 percent in Year 2; 55 percent in Year 3; 70 percent in Year 4; 90 percent in Year 5; and no high-priority invasive plants [as defined in the Reservoir Area Management Plan] shall be present in the Limits of Work at any time during the five-year monitoring).

Mitigation Measure TER-1 Establish a 20-foot buffer around delineated wetlands.
The KRRC shall establish a minimum of a 20-foot buffer around all delineated wetlands potentially affected by construction impacts to ensure there will not be any significant environmental impacts to wetlands by deterring heavy machinery from traversing the wetland and preventing runoff pollution from directly entering the wetland where doing so would not result in a significant environmental impact. The State Water Board has the authority to include this mitigation measure in its water quality certification for the project, and the measure is therefore feasible and used in this analysis to make a significance determination.

With the implementation of these measures, potential short-term impacts on wetlands and riparian areas from construction would be less than significant.

<u>Significance</u>
No significant impact in the short term with mitigation

Potential Impact 3.5-2 Short-term and long-term impacts on wetland and riparian vegetation communities along existing reservoir shorelines due to reservoir drawdown.
Under the Proposed Project, there would be reduction of existing wet habitat at Copco No. 1, Copco No. 2, and Iron Gate reservoirs (currently 15.8 acres of Montane Riparian and 52.3 acres of Palustrine habitat, Table 3.5-2) due to reservoir drawdown, as detailed below:

- Copco No. 1 Reservoir: The shoreline of Copco No. 1 Reservoir currently supports Palustrine Scrub-shrub Wetland where tributary channels enter the reservoir, and Palustrine Forested Wetland occurs along the northwest shore. Small patches of

Palustrine Emergent Wetland also currently exist along the shoreline. These communities would be lost due to reservoir drawdown.

- Copco No. 2 Reservoir: The southern slope of Copco No. 2 Dam currently supports a Palustrine Scrub-shrub Wetland and Palustrine Forested Wetland. Reservoir drawdown would reduce the extent of these wet habitats. These features are not anticipated to be entirely lost because Copco No. 2 Reservoir is relatively small and, therefore, the features will be in close in proximity to the newly exposed river channel.
- Copco No. 2 penstock: Currently, Copco No. 2 penstock leaks water that supports small, local patches of Palustrine Emergent Wetland. Dam and penstock removal would result in the loss of this vegetation.
- Iron Gate Reservoir: Vegetation along the shores of Iron Gate Reservoir includes some Montane Riparian and Palustrine habitat including Palustrine Forested Wetland in the day use and campground areas, and Palustrine Emergent Wetland and Palustrine Scrub-shrub Wetland along Jenny, Scotch, and Camp creeks where tributaries join the reservoir. Reservoir drawdown would reduce the extent of these wet habitats.

Degradation or removal of wetland and riparian habitat in the areas listed above would be a significant short-term and long-term impact.

The Proposed Project includes several actions to encourage rapid revegetation with native riparian species in the reservoir footprints as defined in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) that would ensure no net loss of wetland or riparian habitat acreage and functions. Six locations in Copco No. 1 Reservoir and three locations in Iron Gate Reservoir would be targeted for restoration; these areas would undergo barge-mounted pressure washing/sediment jetting during reservoir drawdown and subsequently would be excavated to the historical floodplain elevation to help create wetlands, floodplain areas, and off-channel habitat features. As depicted in Figures 2.7-11 and 2.7-12, approximately 50 acres of riparian bank would be targeted for revegetation and approximately 100 acres of wetlands, floodplain, and off-channel habitat features would be targeted for restoration. The resulting acreage of restored riparian and wetland vegetation will vary depending on field conditions including the presence of cultural resources and human remains, changes in the topography following drawdown that affect the extent of restorable areas, and changes in topography that affect access; however, given that the proposed acreage to be restored (150 acres) is well above the total acreage potentially impacted (68 acres) the policy of no net loss is anticipated to be achieved.

In addition to restoration in these nine focus areas within Copco No. 1 and Iron Gate reservoirs, prior to drawdown, revegetation activities would include invasive plant species control within the Limits of Work, collection of native plant seed, and propagation of native plants. During the reservoir drawdown period (January to March) and directly afterward, proposed actions within the Limits of Work would include seeding (aerial or potentially barge) of exposed soils, salvaging and planting of existing wetland and riparian vegetation, and evaluation of restoration sites. Following reservoir drawdown (i.e., summer through fall), proposed actions within the Limits of Work would include additional seeding and weed control, and installation of live plants (poles, container plants) as well as acorns. After dam removal is complete and throughout the first year of plant establishment, activities would include additional seeding as necessary, invasive species control, continued plant installation, plant maintenance, and adaptive management of installed habitat features within the Limits of Work.

During the maintenance and monitoring period (years 2 to 5 after revegetation is complete), additional re-seeding and re-planting will be performed in areas that failed to establish and previously seeded and planted areas will be maintained through weed control and irrigation system upkeep. Therefore, short-term impacts on wetland and riparian vegetation would be less than significant, as riparian and wetland vegetation would be actively reestablished along the new river channel and tributaries within the reservoir area in order to meet the proposed success criteria (i.e., percent relative cover at designated reference locations as follows: 70 percent in Year 1; 75 percent in Year 2; 80 percent in Year 3; 85 percent in Year 4; and 90 percent in Year 5).

Following drawdown of the reservoirs, existing upland vegetation is expected to remain unchanged and contribute to successional processes on newly exposed areas. Existing wetland-dependent vegetation along the margins of the reservoirs is expected to die out and transition to upland communities. Wetland species that occur near confluences are expected to conform to the riparian corridor width of the tributaries and over the subsequent years extend down the newly exposed mainstem river channel riparian corridor. Therefore, implementation of the Proposed Project may result in a long-term net increase in the areal extent of riparian and wetland habitat within the terrestrial resources Primary Area of Analysis, largely as part of natural recruitment along newly-exposed mainstem river channel riparian corridor within the former reservoir footprints, but also as a result of active restoration management. Moreover, restored wetlands would benefit from receiving marine-derived nutrients in salmon and other anadromous fish that would have access to Klamath River reaches upstream of Iron Gate Dam once the Lower Klamath Project reservoirs are removed (see also Potential Impact 3.5-27).

The Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) also includes control of invasive plant species (referred to as invasive exotic vegetation [IEV] in the Reservoir Area Management Plan); actions would include invasive plant surveys during pre-dam removal years 1 and 2, invasive plant control during and after drawdown, and monthly inspections for compliance through year 5 and quarterly inspections from years 5 to 10 post-dam removal (Table 2.7-2). Control methods would include manual weed pulling, mowing or cutting, tilling and disking, grazing, solarization, and the potential use of herbicides. Herbicides would be applied as last resort and only use herbicides that have been approved by BLM, CDFW, RWQCB, USFWS, and NMFS. These control measures and monitoring efforts would ensure that impacts on native plant species would be less than significant.

Significance

No significant impact in the short term and long term

Potential Impact 3.5-3 Short-term and long-term impacts on wetland habitat downstream of the Lower Klamath Project dams due to erosion or sediment deposition.

In the reach from Iron Gate Dam to Cottonwood Creek, dam-released sediment may temporarily deposit in pools and other slack water areas (e.g., eddies), at tributary confluences, and potentially along channel margins, where it could have a short-term negative impact on wetland habitat due to temporary burial (USBR 2010). However, the wetland habitat impacts would be localized, and because the transient sediment deposits would be highly erodible during subsequent flow events, the impacts would also be short-term (i.e., likely one year or less except during dry years).

Given that the impacts related to dam-released sediment are likely to be temporary (less than a year) and given that there would not be a substantial modification of federally protected wetlands, there would be a less than significant impact on wetland habitat downstream of the Lower Klamath Project dams.

Significance

No significant impact in the short term and long term

Potential Impact 3.5-4 Effects on riparian habitat downstream of the Lower Klamath Project dams due to short-term and long-term erosion or sediment deposition.

Commenters in the Proposed Project public scoping process expressed concerns regarding erosion and sediment deposition immediately downstream of Iron Gate Dam. Downstream of the Lower Klamath Project dams, river flow rates would not increase substantially above median historical rates. Therefore, rates of bank erosion are not expected to increase significantly (see Potential Impact 3.11-6).

With respect to short-term sediment deposition downstream of the Lower Klamath Project dams, dam-released sediment and sediment resupply would likely extend from Iron Gate Dam to approximately Cottonwood Creek (RM 185.1) (USBR 2012), where reach-averaged deposition of gravel and sediment is projected to be up to one foot between Iron Gate Dam and Bogus Creek (RM 192.68) and up to 0.8 feet between Bogus Creek and Willow Creek (RM 187.8) (see Potential Impact 3.11-5). If rain and snowmelt levels are high during drawdown, relatively less sedimentation would occur in downstream reaches, as there would be higher flows in the system to flush out sediments (Stillwater Sciences 2008). In the short term, reach-averaged sedimentation levels of up to one foot are not expected to substantially negatively impact riparian vegetation downstream of Iron Gate Dam, as vegetation growing within or along the river channel margins is generally adapted to this scale of perturbation due to seasonal and inter-annual sedimentation dynamics typical of river systems. Willow and cottonwood species grow rapidly and can bend, break and re-sprout following sediment deposition (Braatne et al. 1996; Shafroth et al. 2002). Similarly, branches and stems broken off and redeposited with sediment can sprout and grow vigorously on newly deposited alluvium, giving these species a relative advantage over non-sprouting upland or non-native species (Braatne et al. 1996, Rood et al. 2003). Thus, there would be a less than significant effect on riparian vegetation downstream of Iron Gate Dam due to short-term sediment deposition caused by dam removal.

Moreover, sedimentation has the potential to create new surfaces for riparian plants to colonize depending on the sequence of water years following dam removal; under certain scenarios (e.g., wet water year followed by dry water years whereby a lot of sediment is moved and vegetation has time to colonize), this may result in beneficial effects on riparian habitat especially in areas where there is currently less sediment deposit due to upstream sediment trapping in reservoirs (i.e., from Iron Gate to Cottonwood Creek) (Shafroth et al. 2002). Under such scenarios the riparian vegetation would be able to quickly re-establish through colonization. This colonization occurs following disturbance (i.e., deposition-related to removal of the dam) during peak flows that creates substrate for seedlings, followed by declining spring and summer flows that occur during the seed dispersal period. Under this natural process, it is anticipated that new riparian vegetation would become established within three to five years (Riparian Habitat Joint Venture 2009).

In the long term, no permanent loss of riparian habitat due to erosion or sediment deposition is anticipated to occur in any river reach downstream of the Lower Klamath Project dams, and new surfaces for colonization would be created. This would be a beneficial effect.

Significance

No significant impact in the short term

Beneficial in the long term

Potential Impact 3.5-5 Short-term and long-term impacts on native vegetation due to increased invasive plant species establishment.

Under the Proposed Project, there would be potential for invasive plant species in the vicinity to quickly colonize exposed reservoir sediments and other disturbed soil areas and out-compete native plants. In addition, there could be an increase in the transport of invasive plant seeds to downstream areas following removal of the dams, particularly those plants that disperse by water such as Himalayan blackberry and reed canary grass (Nilsson et al. 2010; Merritt and Wohl 2002, 2006; Merritt et al. 2010). Without surveys to document and control invasive plant species they would displace native plants, including special-status species, and degrade habitats, including wetland and riparian vegetation; therefore, this would be a significant short-term impact.

As part of the Proposed Project, invasive plant species would be controlled according to the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*). Actions would include invasive plant surveys initiated prior to dam removal year 1, and invasive monitoring and control over a five-year period with metrics to evaluate success of minimizing invasive exotic vegetation and invasive plant control as necessary. Control methods would include manual weed pulling, mowing or cutting, tilling and disking, grazing, solarization, and the potential use of herbicides. Herbicides would be applied as last resort and only herbicides that have been approved by the BLM, CDFW, RWQCB, USFWS and NMFS would be used. Quarterly inspections would also occur from years 5 to 10 post-dam removal (Table 2.7-1). Additionally, the Reservoir Area Management Plan includes active planting of native species, which will also assist in preventing the establishment of invasive species in disturbed areas. As a result of these actions, potential short- and long-term impacts on native vegetation would be reduced to less than significant.

Significance

No significant impact in the short term and long term

3.5.5.2 Culturally Significant Species

Potential Impact 3.5-6 Short- and long-term impacts on culturally significant species in riparian and wetland habitats.
Many of the species identified by the Native American Tribes in the Klamath River region as culturally significant occur in riparian and wetland habitats. Project activities including construction as well as reservoir drawdown would result in population-level impacts to culturally significant plant species or substantial degradation or removal of wetland and riparian habitat; therefore, there would be a significant short-term and long-term impact on culturally significant species.

The Proposed Project includes several actions to survey for wetlands and encourage rapid revegetation with native riparian species in the reservoir footprints as defined in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) that would ensure no net loss of wetland or riparian habitat acreage and functions. The revegetation mixes will be developed based on updated inventories of existing wetland and riparian vegetation around the reservoir perimeters; therefore, culturally significant species will be documented and incorporated as part of the revegetation effort. In addition, Mitigation Measure TER-1 (see Potential Impact 3.5-1) includes wetland buffers to prevent intrusion in wetland habitats, deter heavy machinery from traversing the wetland, prevent runoff pollution from directly entering the wetland, and avoid substantial degradation in these areas. These measures would ensure that impacts on culturally significant species would be less than significant.

Significance
No significant impact with mitigation in the short term

No significant impact in the long term

3.5.5.3 Special-status Species and Rare Natural Communities

Potential Impact 3.5-7 Short-term impacts on special-status plants and rare natural communities from construction-related activities.
Construction activities including road, bridge, hatchery modifications, and culvert improvements (Section 3.22.2.3 *Road Conditions*) could result in direct mortality or damage to special-status plant species or indirect damage by degrading special-status plant habitat (e.g., introducing invasive plant species) or rare natural communities. Special-status plant species with the potential to occur in the Primary Area of Analysis for terrestrial resources are provided in Table 3.5-4 and rare natural communities with the potential to occur in the Primary Area of Analysis for terrestrial resources are provided in Appendix H. Construction activities would require heavy machinery to move through construction areas, staging areas, and haul roads where these species could occur. Contact with construction vehicles could result in direct mortality or damage to these species or their habitat. Special-status plants and rare natural communities may be present in the areas where construction activities may be performed; without surveys to document these species and habitats and measures to adequately protect them, they would be removed and/or habitat would be degraded; therefore, this would be a significant short-term impact.

As part of the Proposed Project, comprehensive floristic surveys would be conducted for special status-plants within the construction Limits of Work where ground-disturbing activities would occur plus an established buffer (i.e., a 100-meter buffer around disposal sites and a 10-meter buffer along access and haul roads) following the CDFW guidelines (CDFG 2009; Appendix B: *Definite Plan – Appendix J*) and the vegetation maps would be updated to reflect existing conditions including any rare natural communities that may present. The Proposed Project includes avoidance and minimization measures as well as provisions for the establishment of wetland and riparian areas and other sensitive vegetation communities within the project area to result in no net loss of habitat acreage (CDFG 2009; Appendix B: *Definite Plan – Appendix J*); therefore, impacts to rare natural communities would be less than significant.

If any special-status plants are documented, the Proposed Project design would be modified if possible to avoid them. Where avoidance is not feasible, a combination of relocation, propagation, and establishment of new populations in designated conservation areas would be implemented, as determined in coordination with the resource agencies and invasive plant species would be controlled by implementing measures such as routine washing of construction vehicles and equipment (Appendix B: *Definite Plan – Appendix J*). There may be significant impacts on special-status plants where avoidance is infeasible and if replanting does not succeed in re-establishment of new populations at a 1:1 ratio such that there is no net loss of individuals. If implemented as part of the Final Restoration Plan, Recommended Terrestrial Measure 1 would reduce impacts to less than significant. KRRC proposes that KRRC and the appropriate state or local agency would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be 'good citizens' of the communities in which projects are located and thus to comply, where possible, with state and local requirements. Overseeing development and implementation of terms and conditions relating to protection of terrestrial special-status plants and/or rare natural communities does not fall within the scope of the State Water Board's water quality certification authority. While the State Water Board anticipates that implementation of the entire Final Restoration Plan, including the aforementioned additional details and any modifications developed through the FERC process that provide the same or better level of protection for special-status plants, would reduce impacts to less than significant. However, because the State Water Board cannot ensure implementation of the terrestrial aspects of the Final Restoration Plan , it is analyzing the impact in this Draft EIR as significant and unavoidable.

Recommended Terrestrial Measure 1 – Establish Mitigation Ratios for Special-Status Plants.

The Final Restoration Plan shall include a minimum 1:1 mitigation ratio and a Plant Mitigation and Monitoring Plan shall be developed for any special-status species that would be impacted by the Proposed Project. These features of Recommended Terrestrial Measure 1 would be implemented such that any impact to special-status plants would be less than significant.

Significance

No significant impact on rare natural communities in the short term

Significant and unavoidable impacts on special-status plants in the short term

Potential Impact 3.5-8 Short- and long-term impacts on special-status plants from reservoir removal.

Wetland habitat at reservoir margins supports potential habitat for several species of special-status plants (Table 3.5-4). There is potential for special-status plants to occur at the Lower Klamath Project reservoirs, and therefore there would be loss of habitat for these individual plants once the reservoirs are removed. Without surveys to document these species and measures to adequately protect them, they would be removed and/or habitat would be degraded; therefore, this would be a significant short-term impact.

As discussed above, implementation of the Proposed Project may result in a net increase in the areal extent of riparian and wetland habitat within the Primary Area of Analysis, largely as part of natural recruitment along newly-exposed mainstem river channel riparian corridors within the former reservoir footprints, but also as a result of active restoration management as described in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*). The Reservoir Area Management Plan also includes focused surveys (i.e., the species listed in Table 3.5-1, Preliminary List of Special Status Plants with Potential to Occur in or near the Limits of Work) for special-status plants in areas such as reservoir shorelines where changes in hydrology and geomorphology will occur due to the Proposed Project and includes provisions for the establishment of special-status plants, if any are documented within these areas.

There would be significant impacts on special-status plants if those plants are not captured during the targeted surveys and also where avoidance of documented and undocumented special-status plants is infeasible and replanting does not succeed in re-establishment of new populations. If implemented, Recommended Terrestrial Measure 2 and Recommended Terrestrial Measure 1 would reduce impacts to less than significant. KRRC proposes that KRRC and the appropriate state or local agency would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be 'good citizens' of the communities in which projects are located and thus to comply, where possible, with state and local requirements. Overseeing development and implementation of terms and conditions relating to protection of terrestrial special-status plants does not fall within the scope of the State Water Board's water quality certification authority. The State Water Board anticipates that implementation of the entire Final Restoration Plan, including the aforementioned additional details and any modifications developed through the FERC process that provide the same or better level of protection for special-status plants, would reduce impacts to less than significant. However, because the State Water Board cannot ensure implementation of the terrestrial aspects of the Final Restoration Plan, it is analyzing the impact in this Draft EIR as significant and unavoidable.

Recommended Terrestrial Measure 2 – Update Scoping Lists for Special-Status Plants.

The Final Restoration Plan shall include an updated list of special-status plants with the potential to occur in wetland and riparian habitats.

Significance

Significant and unavoidable in the short term and long term

Potential Impact 3.5-9 Short-term impacts on special-status terrestrial invertebrates from construction-related activities.

The special-status invertebrates identified as having the potential to occur in the terrestrial Primary Area of Analysis include USDA Forest Service and BLM sensitive species, which receive protection on USDA Forest Service and BLM lands, respectively. No construction-related impacts on USDA Forest Service or BLM special-status invertebrates are anticipated on USDA Forest Service or BLM lands. Most of the land within the Limits of Work, where direct construction-related impacts would have the potential to occur, is private and includes reservoir-type habitat, which does not currently provide necessary habitat components required for upland terrestrial invertebrate species. There are no USDA Forest Service land within the Limits of Work, and there is only a very small amount (<3 percent) of BLM lands (Figure 2.1-1).

The Oregon shoulderband, Trinity shoulderband, Siskiyou shoulderband, and Tehama chaparral are terrestrial snails associated with exposed rock or rock talus habitat. This habitat is not present on BLM lands that overlap the Limits of Work (Appendix G). Rock talus habitat is present just downstream of Copco No. 2 Dam and may support habitat for these species. This habitat is present in numerous locations throughout the Primary Area of Analysis for terrestrial resources (Appendix G) and any short-term construction-related activities in this specific area would not be expected to impact any federal species of special concern on a population level, if present.

The Western bumblebee is associated with shrub, chaparral, and open grassy areas, and there is a relatively small amount of this habitat within the Limits of Work, as the majority of these habitats include existing reservoirs and shoreline habitat. If present, the species would likely fly to adjacent habitat as annual and perennial grasslands are common in habitats surrounding the Limits of Work. As a result, no population-level impacts are anticipated.

As no population-level impacts are anticipated on special-status invertebrates, there would be no significant impacts on special-status terrestrial invertebrates due to short-term construction-related activities under the Proposed Project.

Significance

No significant impact

Potential Impact 3.5-10 Short-term impacts on special-status amphibian, reptiles, and mammals from construction activities.

Construction activities including, but not limited to, structure demolition; hatchery modifications (Section 2.7.6 *Hatchery Operations*); road, bridge, and culvert improvements (Section 3.22.2.3 *Road Conditions*); and, use of heavy equipment to transport sediment during reservoir drawdown or to grade floodplain areas to support wetland and restoration of natural habitats (Appendix B: *Definite Plan – Appendix H*), could result in direct mortality or harm to special-status amphibian, reptile, and mammal species or associated habitat with the potential to occur in the Primary Area of Analysis for terrestrial resources (see Table 3.5-5 for the list of species). Construction activities that may affect habitat, result in direct contact to individuals, or result in indirect impacts on individuals, include demolition of structures, digging holes or trenches where wildlife may be trapped, and movement of heavy machinery through construction areas, staging areas, and along haul roads where these species could occur.

Terrestrial resources avoidance and minimization measures included in the Proposed Project, such as installing construction fencing around the work area, would be an effective means to reduce the potential for medium and large mammals to enter the work area and become entrapped; however, the presence of fencing has the potential to keep animals in the work area if they have managed to cross into the work area and/or to become trapped in the fencing. Effects of construction-related noise and vibration are not anticipated to affect amphibians and reptiles, and for mammals dispersing through the Primary Area of Analysis, it is expected that they would move to adjacent suitable habitat. Construction-related noise and vibration impacts on roosting bats are discussed in Potential Impact 3.5-14.

To date, KRRC has conducted the following surveys for the Proposed Project:

- A field reconnaissance survey in July 2017 to gather information on habitat and identify access for subsequent wildlife surveys (spring and summer 2018), focusing on locations within the Limits of Work where special-status species were documented by PacifiCorp in 2001–2003.
- General Wildlife Surveys in May and June 2018, involving documentation of baseline information on the presence of special-status species and their habitats, which included documenting any wildlife signs such as dens or burrows.

The aforementioned short-term construction-related activities would result in a significant impact on special-status amphibians, reptiles, and mammals, if present during construction. The Proposed Project includes multiple components to avoid and minimize construction-related impacts on wildlife species including, but not limited to, the components listed below (additional details are provided in Appendix B: *Definite Plan Appendix J – Terrestrial Resource Measures*). Proposed Project avoidance and minimization measures include the following:

- Developing a Construction Monitoring Plan in coordination with resource agencies
- Providing a biological monitor to ensure compliance with protective measures during clearing and construction activities within designated areas;
- Training employees about special-status species and action to be taken upon sighting of special-status species during construction;
- Fencing construction areas and implementing measures to reduce wildlife entrapment in excavated holes or trenches;
- Monitoring coffer dams following closure and prior to the start of construction activities for the presence of western pond turtles, and if present, capture and relocate;
- Requiring crews maintain a 20-miles per hour speed limit on all unpaved roads to reduce wildlife being harmed via impact with vehicles;
- Requiring proper disposal of trash and food into closed containers generated during construction, and trash to be removed once a week from the site;
- Preventing presence of pets, feeding of wildlife, or use of firearms;
- Maintaining equipment, if necessary, in designated staging areas; and
- Reporting to CDFW and USFWS the observation of any dead, injured, or entrapped state or federally listed species.

While the Proposed Project avoidance and minimization measures would reduce the potential for short-term construction-related impacts on wildlife species within the Primary Area of Analysis, several of the aforementioned components need more specificity to ensure that short-term construction activities would not result in significant impacts on special-status species amphibians and reptiles or substantially interfere with movement and/or migration of these species, or that any remaining potentially significant impacts are mitigated to the extent feasible. Implementation of the mitigation measures below, developed in consultation with CDFW, would reduce potential short-term construction-related impacts on special-status amphibian and reptiles to less than significant.

Further, several of the aforementioned components unrelated to amphibians or reptiles also need more specificity to ensure that short-term construction activities would not result in significant impacts on special-status species or substantially interfere with movement and/or migration of wildlife species, or that any remaining potentially significant impacts are mitigated to the extent feasible. KRRC proposes that KRRC and the appropriate state or local agency would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be 'good citizens' of the communities in which projects are located and thus to comply, where possible, with state and local requirements.

It would be appropriate for the recommended terms and conditions relating to protection of terrestrial wildlife species other than amphibians and reptiles to include the Recommended Terrestrial Measures below, which have been developed in consultation with CDFW and USFWS. The Recommended Terrestrial Measures include additional components beyond those listed as part of the Proposed Project and would be necessary to reduce potential short-term construction-related impacts on special-status to less than significant, as specifically discussed in each measure (see Table 3.5-6 and the measures themselves). The Recommended Terrestrial Measures are consistent with widely accepted professional best management practices for environmental protection which would reduce potential harm to special-status species.

Overseeing development and implementation of terms and conditions relating to protection of terrestrial wildlife species does not fall within the scope of the State Water Board's water quality certification authority unless the species has a particular nexus with water – for example, it is a wetland or riparian species or primarily eats fish. In this case, there are mitigation measures pertaining to amphibian and reptiles that the State Water Board can ensure through the water quality certification. Therefore, these mitigation measures (TER-2 and TER-3) are considered as part of the impact analysis and determination of significance.

While the KRRC has initiated a process[113] to reach enforceable good citizen agreements with USFWS and CDFW that will be finalized and implemented, at this time the terms and conditions relating to protection of terrestrial wildlife species without a nexus to water are not finalized and the State Water Board cannot require their implementation.

[113] KRRC submitted the *Klamath River Renewal Project California Environmental Quality Act (CEQA) and California and Oregon 401 Water Quality Certifications Technical Support Document* (AECOM et al. 2017a) to USFWS and CDFW in September 2017 and requested feedback by November 10, 2017.

Accordingly, while the State Water Board anticipates that implementation of the final terms and conditions, including the Recommended Terrestrial Measures, and any modifications developed through the FERC process that provide the same or better level of protection for special-status wildlife, would reduce impacts to less than significant, because the State Water Board cannot ensure implementation of the Recommended Terrestrial Measures, it does not consider the Recommended Terrestrial Measures in this analysis and is analyzing the associated impacts to mammals in this Draft EIR as significant and unavoidable.

Mitigation Measure TER-2 – Amphibian and Reptile Management.
As described in the Draft Clean Water Act Section 401 Water Quality Certification for California Condition 15 *Amphibian and Reptile Management*, no later than three months following issuance of a FERC license surrender order, KRRC shall submit an Amphibian and Reptile Rescue and Relocation Plan (Amphibian and Reptile Plan) to the State Water Board Deputy Director for review and approval prior to drawdown, in-water work, and work in riparian areas. The Amphibian and Reptile Plan shall identify protection measures that when implemented by KRRC will avoid direct mortality or harm to special-status amphibian and reptile species with the potential to occur in the Primary Area of Analysis for terrestrial resources. The Amphibian and Reptile Plan shall also specify survey protocols, locations, and frequency; rescue and relocation techniques; and reporting requirements. Species covered in the Amphibian and Reptile Plan shall include amphibians and reptiles found within the terrestrial Primary Area of Analysis that are listed under the federal ESA or the CESA or are designated as Species of Special Concern by CDFW. These species may include, but are not limited to: southern torrent salamander, Scott Bar salamander, Siskiyou Mountains salamander, Pacific tailed frog, foothill yellow-legged frog, northern red-legged frog, and western pond turtle. These features of TER-2 will be implemented such that there is no significant impact on special-status amphibians and reptiles.

Mitigation Measure TER-3 – Western Pond Turtle Pre-construction Surveys.
As described in the Draft Clean Water Act Section 401 Water Quality Certification for California Condition 15 *Amphibian and Reptile Management,* KRRC shall protect western pond turtle, which has been designated by CDFW as a Species of Special Concern and is present within the Primary Area of Analysis.

KRRC shall conduct western pond turtle pre-construction surveys and reporting, as described below. An on-site biologist approved by the applicable agencies to specifically conduct western pond turtle pre-construction surveys shall be familiar with the ecology of western pond turtle. This on-site biologist shall conduct pre-construction surveys immediately prior to the start of any in-water work each day that in-water work will occur. Any adult western pond turtles that are found during surveys shall be relocated to a safe location, by an agency-approved biologist, outside of the work area and away from indirect impacts. An appropriate relocation site shall be designated prior to the start of construction. Pre-construction surveys shall be consistent with the Amphibian and Reptile Management Plan (TER-2). (This measure is specific to construction activities, such as cofferdams, and is not intended to be implemented during reservoir drawdown.)

A report shall be submitted to applicable agencies within 30 days of completing the Proposed Project. The report shall include the following information regarding all species handled and relocated; location, date, time and duration of the handling; enumeration and identification of species handled; identification of species life stage;

identification of capture personnel; the release location and time; stream, transport, and receiving water temperatures; and location, date, and time of release. These features of TER-3 will be implemented such that there is no significant impact on western pond turtles.

Table 3.5-6. Summary of Proposed Project Components and Recommended Terrestrial Measures.

Proposed Project Avoidance and Minimization Measure Component	Recommended Terrestrial Measure
Biological monitoring and the development of a detailed Construction Monitoring Plan[114] in coordination with the resource agencies	**Recommended Terrestrial Measure 3** further requires agency approval of on-site biologists and identifies monitoring and reporting requirements to incorporate in the Construction Monitoring Plan.
Mandatory biological resource awareness training for all construction personnel	**Recommended Terrestrial Measure 4** requires additional items, including consideration of exotic and noxious species and appropriate decontamination measures as part of the training, identifies the reoccurrence interval of the training, and stipulates that the training shall be interpreted for non-English speaking workers.
Requirements for construction personnel including disposing of trash, maintain construction related-traffic in construction boundaries, no feeding of wildlife, no pets, no firearms, maintaining equipment in staging areas, reporting on state-listed or federally-listed species	**Recommended Terrestrial Measure 5** includes the additional requirements that (1) all food-related trash items would be disposed of in closed wildlife-proof containers to reduce the potential for special-status wildlife to enter the Limits of Work, and; (2) equipment would be power washed prior to arriving at the site to reduce potential for non-native species to enter the Limits of Work and compete with special-status species or spread to nearby habitats.
Requirements for wildlife exclusion and entrapment	**Recommended Terrestrial Measure 6** in addition to providing a requirement for wildlife exclusion and entrapment, this provides an additional requirement for fencing to be checked daily during active construction to ensure that it remains intact.
Surveys to identify special-status amphibian and reptile habitat and quantity affected, mammal sign, including den sites or burrows, will be noted.	**Recommended Terrestrial Measure 7** includes special-status species identified in Table 3.5-5 to be included for habitat assessments, and if present, for inclusion in pre-construction surveys. **Recommended Terrestrial Measure 7** also requires that an on-site biologist preform daily pre-construction wildlife surveys prior to initiating construction activities.
Identifying wolves during general wildlife surveys	**Recommended Terrestrial Measure 8** includes further means to monitor the CDFW gray wolf activity map, and if wolf activity identified on the map overlaps with the Lower Klamath Project, or if a wolf is observed during any Proposed Project survey or monitoring effort, CDFW would be consulted to further evaluate site-specific measures depending on the time of year and information about the individuals in the area.

[114] No specific details were provided in the Construction Monitoring Plan other than the plan would be developed in coordination with resource agencies (Appendix B: *Appendix J – Terrestrial Resource Measures*).

Recommended Terrestrial Measure 3 – On-site Biologist/Construction Monitoring Plan.

The Construction Monitoring Plan, as referenced in KRRC's Definite Plan (Appendix B: *Appendix J – Terrestrial Resource Measures*) shall be developed prior to implementing construction (ground disturbing activities) and include where and when monitoring would occur, requirements and roles of an on-site biologist, resource monitored, and reporting requirements. The Construction Monitoring plan details would include the information below.

An on-site biologist (often referred to as a biological monitor or construction monitor) shall be present during construction-related activities to reduce the potential for impacts on special-status wildlife species and nesting birds that are protected by CDFW and USFWS. The role of the on-site biologist shall include, but is not limited to, identifying wildlife species within or adjacent to the work area that may be affected; clearing each work area daily (including individual areas such as each staging area, structure demolition area, bridge upgrade location) of wildlife species prior to the initiation of an activity (as discussed in Recommended Terrestrial Measure 7); observing changes in wildlife behavior; identifying species if they enter the work area and relocating them to a designated location identified prior to Proposed Project activities; developing site- and species-specific minimization measures to prevent impacts on special-status species or sensitive habitats and advising crew of these minimization measures which could include stopping work until the wildlife was no longer in the work area or implementing buffers; communicating daily at tailboards with the construction crew about special-status wildlife activity in the area; and coordinating with agencies for guidance, as needed. The on-site biologist has stop-work authority for any activity in order to avoid unauthorized take of a special-status species.

The on-site biologist shall be knowledgeable and experienced in the biology, natural history, collecting, and handling of species that may be encountered. CDFW and USFWS must approve the on-site biologist's qualifications prior to start of construction; such approval shall occur within a timely fashion.

During any construction-related (i.e., staging, facility removal, restoration) activity, the on-site biologist shall be present at locations where the activity is occurring. A minimum of one on-site biologist shall be present at each earth-moving or structure demolition location (e.g., dam location, staging area, bridge upgrade). It would be reasonable to assume, depending on the level of proposed activity, one biologist can monitor areas that are immediately adjacent to each other. This measure is specific to construction activities and is not intended to be implemented during reservoir drawdown.

The on-site biologist shall prepare daily written observation and inspection records that summarize observed special-status species and minimization measures employed. These records shall be submitted at least monthly to CDFW, USFWS, and the State Water Board. The on-site biologist shall submit all observations of state species of special concern and candidate, threatened, or endangered species under the state or federal Endangered Species Act (ESA), to the California Natural Diversity Database within 60 calendar days of the observation, and copies of the submitted forms shall be included with the monthly report.

If a species of special concern, candidate, threatened, or endangered species is harmed by the Proposed Project, or found dead within the Limits of Work, initial notification to the respective resource agencies shall include information regarding the location, species, and number of animals taken or injured with 24 hours of discovery. Following initial notification, a written report shall be provided to the respective resource agencies within two calendar days and shall include any additional measures to implement for the duration of the Proposed Project to avoid additional injury to species of special concern, candidate, threatened, or endangered species. The report format shall be developed in coordination with CDFW and shall include the date and time of the finding or incident, the location of the animal or carcass, a photograph (if possible), an explanation as to cause of harm, and any other pertinent information. If the incident was a result of the Proposed Project, the report will include a recommendation that would be implemented in order to avoid additional injury to special-status species of special concern, candidate, proposed, threatened, or endangered species.

Recommended Terrestrial Measure 4 – Biological Resources Education and Awareness Training.
A mandatory biological resource education and awareness training shall be provided by a biologist approved by the resource agencies (USFWS and CDFW) for all on-site Proposed Project personnel and their associated supervisor. All persons shall receive the training prior to performing any ground-disturbing (including vegetation clearing and grading) work. This training shall inform Proposed Project personnel about special-status species that could occur on site. The training shall, at a minimum, consist of: (1) a brief introduction to the special-status species and identifying characteristics, including a short discussion of the biology, life history, habitat requirements, status, and legal protection; (2) measures being taken for the protection of these species and their habitats; and (3) actions to be taken if a special-status species is found within the area during construction activities. Species identification cards shall be issued to shift supervisors; these cards shall have photos, descriptions, and actions to be taken upon sighting of special-status species during construction. The training shall also include information on exotic and noxious species and appropriate decontamination measures. This training shall be repeated at least once annually and shall be provided to any new Proposed Personnel before beginning work activities, and if a change in special-status species occurs that requires further consideration. The KRRC shall provide interpretation for non-English speaking workers. Training Proposed Project personnel on special-status species will increase the potential of documenting special-status species in the construction area and allow for the on-site biologist to implement measures (e.g., rescue and relocate, implement buffers) to reduce impacts on the species to less than significant. Upon completion of the training, all employees shall sign an acknowledgment form stating that they attended the training and understand all protection measures. Tracking of training activities shall be reported monthly to applicable agencies.

Recommended Terrestrial Measure 5 – Requirements for Construction Personnel.
Establishing requirements for construction personnel will reduce the potential impacts on special-status terrestrial resources to less than significant by ensuring construction activities are occurring within designated boundaries and reducing the potential for wildlife to enter the work area or be affected by equipment. These requirements are described below.

- The KRRC shall clearly delineate the Limits of Work and prohibit any construction-related traffic outside of these boundaries.
- KRRC shall require construction crews to maintain a 20 mile per hour speed limit on all unpaved roads to reduce the chance of wildlife being struck.
- KRRC shall require that no deliberate feeding of wildlife shall be allowed and all food-related trash items shall be disposed of in closed wildlife-proof containers (e.g., bear-proof trash cans) and removed at least once a week.
- If vehicle or equipment maintenance is necessary, it shall be performed in the designated staging areas with adequate spill containment.
- Any worker who inadvertently injures or kills a federally or state-listed species, bald eagle, or golden eagle, or finds one dead, injured, or entrapped shall be required to immediately report the incident to the construction supervisor and on-site biologist. The on-site biologist shall notify the resource agencies within 24 hours of the incident.
- All equipment shall be power-washed prior to arriving to and leaving the site to minimize the spread of non-native wildlife and exotic and noxious plants species to reduce the chance of impacts on special-status species and their habitats.
- Tracking of these requirements shall be reported monthly to applicable agencies.

Recommended Terrestrial Measure 6 – Wildlife Exclusion and Entrapment. Construction areas, including staging areas and access routes, shall be fenced with high-visibility fencing to demarcate work areas to reduce the potential for terrestrial species to enter the work area and be harmed by construction equipment. An on-site biologist (see Recommended Terrestrial Measure 3) shall confirm the location of the fenced area prior to habitat clearing, and the fencing shall be maintained throughout the construction period and checked daily when active construction is occurring to ensure that it remains secure and intact and that no wildlife are trapped by the fencing. Additional exclusion fencing or other appropriate measures shall be implemented in consultation with the resource agencies if necessary to prevent use of construction areas by special-status species during construction. Installing visible construction fencing does not apply to the reservoir areas during drawdown or areas being restored with planting of vegetation, but rather staging and active construction areas.

To prevent entrapment of wildlife at construction sites, all excavated, steep-walled holes or trenches in excess of two feet deep shall be inspected by a biologist or construction personnel approved by the resource agencies at the start and end of each working day. If no animals are present during the evening inspection, plywood or similar materials shall be used to immediately cover the trench, or one or more escape ramps shall be set in the trench at no greater than 1,000-foot intervals and constructed of earth fill or wooden planks. Trenches and pipes shall be inspected for entrapped wildlife each morning prior to onset of activity. Before such holes or trenches are filled, they shall be thoroughly inspected for entrapped animals. Any animals so discovered shall be allowed to escape voluntarily, without harassment, before activities resume, or removed from the trench or hole by the biologist and the animals shall be allowed to escape unimpeded.

Tracking of wildlife exclusion and entrapment activities shall be reported monthly to applicable agencies. Should wildlife be found entrapped, the on-site biologist shall identify if modifying construction or monitoring activities would reduce potential for future impacts and implement as feasible to prevent mortality of special-status species.

Recommended Terrestrial Measure 7 – General Special-status Wildlife Surveys and Pre-construction Surveys.
A general special-status wildlife survey shall be conducted within 24 months of initial habitat modification associated with construction activities (e.g., grubbing, structure modification) within the Limits of Work to assess the presence of any special-status species and potential for habitat to be present that could support special-status species identified in Table 3.5-5. Surveys shall be conducted by a qualified biologist; such approval shall occur in a timely fashion. If suitable habitat is present, and there is potential for special-status species to be present, a biologist shall further assess if these special-status species are present in the Limits of Work by conducting general visual observation surveys or protocol-level surveys. Surveys for nesting birds are discussed in Recommended Terrestrial Measure 9, willow flycatcher in Recommended Terrestrial Measure 10, bald and golden eagle in Recommended Terrestrial Measure 11, bats in Recommended Terrestrial Measure 12; surveys to be consistent with the Amphibian and Reptile Management Plan discussed in Mitigation Measure TER-2.

Pre-construction surveys shall be conducted daily by the on-site biologist (as identified in Recommended Terrestrial Measure 3) at each location where construction is occurring prior to initiation of construction. If special-status species are present (excluding state or federally listed as threatened, endangered, or candidate species), they shall be captured and relocated out of harm's way to a suitable area designated prior to initiating the Proposed Project activities that have the potential to affect the species, in a way that is consistent with recommended measures for bats (Recommended Terrestrial Measure 12) and Mitigation Measures for western pond turtle pre-construction surveys (TER-4) and the Amphibian and Reptile Management Plan (TER-2). General special-status wildlife surveys and pre-construction surveys shall be reported monthly to applicable agencies.

Recommended Terrestrial Measure 8 – Gray Wolf.
Every six months, the location of gray wolves shall be assessed using the CDFW gray wolf activity map (CDFW 2018a). If the Lower Klamath Project overlaps with known wolf activity as identified in the CDFW wolf activity map or if a wolf is documented during any Proposed Project surveys or monitoring, CDFW shall be contacted to further determine if activities pose any potential impacts on gray wolves, particularly with respect to potential modification or disruption of key pup-rearing areas such as dens and rendezvous sites. Depending on the time of year and information about the pack or individuals in the area, CDFW may identify additional measures including denning surveys, reduced driving speeds, limited operating periods, disturbance buffers, reduced speed and signage on haul roads, modification of haul roads to avoid key areas, and monitoring. Tracking of gray wolf activities shall be reported every six months to applicable agencies.

Significance
No significant impact with mitigation for amphibians and reptiles

Significant and unavoidable for mammals

Potential Impact 3.5-11 Short-term impacts on nesting birds from construction-related noise and habitat alterations.

In the short term, construction activities including, but not limited to, structure demolition, hatchery modifications (Section 2.7.6 *Hatchery Operations*), road and bridge upgrades (as discussed in Appendix B: *Definite Plan – Appendix K*), and culvert improvements (Section 3.22.2.3 *Road Conditions*) could result in disturbance to or mortality of nesting birds.

Impacts on bald and golden eagles are discussed in Potential Impact 3.5-13 and on northern spotted owl in Potential Impact 3.5-15. Potential impacts on native birds during the breeding season, including several special-status species, many of which are referenced in Table 3.5-5, could occur under the Proposed Project including species such as peregrine falcon and non-special-status species such as swallows (northern rough-winged, tree, violet-green) (eBird 2018). Potential impacts could result from nest abandonment due to construction noise above ambient conditions, as well as habitat removal resulting from construction activities or physical harm. Examples of construction activities that could result in noise disturbance include dam demolition and loud blasting activities, use of helicopters or planes during restoration activities, noise disturbance during removal of transmission lines, and use of general construction equipment (e.g., cranes, dozers, front loaders). Dam removal activities would be initiated in March, which is relatively early in the bird nesting season (February 1 through August 31) (Appendix B: *Definite Plan – Appendix H*). Examples of construction activities that could result in harm to an active nest include removing vegetation, clearing of access and haul roads, removing existing structures, and creating staging and disposal sites. Without surveys to document nesting special-status birds and buffers to prevent noise and habitat removal impacts, special-status nesting bird species, if present, would be displaced resulting in a failed nest or mortality to young, and this would be a significant short-term impact.

The Proposed Project includes multiple components to avoid and minimize short-term construction-related impacts on bird species (Appendix B: *Definite Plan – Appendix J*) which include, but are not limited to, the components below (additional details are provided in Appendix B: *Definite Plan Appendix J – Terrestrial Resource Measures*).

- The following surveys were recently conducted for the Proposed Project.
    - As part of the General Wildlife Surveys, KRRC conducted special-status bird species surveys in May and June 2018 within the Limits of Work and within 0.25 miles of dams and structures to be removed, disposal sites, and haul and access roads. KRRC noted species seen or heard.
    - As part of the Nest Surveys, KRRC conducted nest surveys in May 2018 and focused on special-status species that may return to the same nest location (e.g., osprey, peregrine falcon, greater sandhill crane). Surveys for osprey were conducted at suitable nesting locations within 0.75 mile of the Limits of Work, peregrine falcon nests were surveyed at cliff locations within one mile of the Limits of Work, and greater sandhill crane nesting habitat was surveyed at J.C. Boyle Reservoir. Heron colonies were also surveyed along reservoir and river shorelines within 0.25 mile of the Limits of Work, KRRC noted all species seen or heard, and active nests were documented.

- Future measures include the following:
  - o Implementing pre-construction bird nesting surveys two weeks prior to construction within 300 feet of the Limits of Work and removing non-active nests (i.e., those without eggs) outside of the non-bird nesting season to discourage future nesting.
  - o Surveying for osprey at nest sites identified in 2018 for occupancy in the year construction activities are planned to commence, and consulting with agencies on nests within 0.75 mile of the Limits of Work to block or remove nest to prevent future nesting.
  - o Surveying for heron colonies and peregrine falcon and greater sandhill cranes in the spring of the year prior to drawdown, and if an active nest documented, a spatial buffer may be established in coordination with resource agencies.
  - o Removing nesting habitat for osprey and nests of other raptors (other than eagles) prior to the bird nesting season[115].
  - o Removing vegetation outside of the bird nesting season (February through July)[115].

While the Proposed Project avoidance and minimization measures would reduce the potential for short-term construction-related impacts on nesting birds within the Primary Area of Analysis, several of the aforementioned components need more specificity to ensure that short-term construction activities would not result in significant impacts on special-status species or substantially interfere with movement and/or migration of wildlife species, or that any remaining potentially significant impacts are mitigated to the extent feasible. KRRC proposes that KRRC and the appropriate state or local agency would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be 'good citizens' of the communities in which projects are located and thus to comply, where possible, with state and local requirements.

It would be appropriate for the recommended terms and conditions relating to protection of nesting birds to include Recommended Terrestrial Measure 9 below, which was developed in consultation with CDFW and USFWS. This recommended terrestrial measure includes additional components beyond those listed as part of the Proposed Project, including, but not limited to, the following:

- extending the bird nesting season through August 31st (i.e., February 1 through August 31[116,117]);
- implementing pre-construction nesting bird surveys within one week of the construction activity, and include surveys for raptors within 500 feet of the construction activity; and

[115] Removing suitable nesting habitat (e.g., platforms, vegetation) outside of the bird nesting season would reduce the potential for birds to nest in the area and be subject to construction-related disturbance (noise, habitat removal) during the breeding season.
[116] Bird nesting season identified by A. Henderson, CDFW, Environmental Scientist, pers. comm October 2017. Timing may be modified by CDFW based on nesting information collected in the Area of Analysis.
[117] The nesting season identified in the Proposed Project included two date ranges—February through July and January 1 through August 20.

- consulting with CDFW and USFWS for buffer distances associated with (a) special-status species and (b) raptors not included in Table 3.5-5, or if a modified buffer is proposed.

Although removing individual active nests of non-special-status bird or CDFW special-status species would not rise to the level of population-level impacts, loss of a state- or federally- threatened active nest may affect populations levels and thus impacts on one individual or a nest may result in a significant impact.

Overseeing development and implementation of recommended term and conditions relating to nesting birds does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has initiated a process[118] to reach enforceable good citizen agreements with USFWS and CDFW that will be finalized and implemented, at this time the recommended term and conditions are not finalized, and the State Water Board cannot require their implementation. Accordingly, while the State Water Board anticipates that implementation of the recommended term and conditions, including the Recommended Terrestrial Measures and any modifications developed through the FERC process that provide the same or better level of protection for special-status wildlife, would reduce impacts to less than significant, because the State Water Board cannot ensure implementation of the Recommended Terrestrial Measures, it is analyzing the associated impacts in this Draft EIR as significant and unavoidable.

Recommended Terrestrial Measure 9 – Nesting Birds.

- Removal or trimming of any trees or other vegetation for construction shall be conducted outside of the nesting season (February 1 through August 31[119]). This shall include removal or trimming of trees along access roads and haul routes and within disposal sites. When this activity cannot occur (e.g., unanticipated activity, unanticipated delays, or vegetation re-grew during the growing season), a nesting bird survey (as described below) shall be conducted prior to vegetation removal. Where clearing, cutting, grubbing, or structural removal/modification cannot occur outside the nesting season (e.g., not feasible with construction schedule, unanticipated activity), a nesting bird survey (as described below) shall be conducted prior to habitat removal.
- Nesting bird surveys shall be conducted by a qualified avian biologist approved by CDFW and USFWS. The avian biologist shall survey the nesting habitat (vegetation, buildings) to be removed in the construction area and suitable habitat buffering the construction area—within 500 feet for raptors (other than eagles) and within 300 feet for non-special status non-raptors (e.g., song birds) Surveys should be conducted within one week[120] prior to habitat removal to determine if any native birds are nesting in those areas and have the potential to be affected by habitat removal. Surveys may be repeated beyond that described above (i.e., one week prior to habitat disturbance) to ensure that no nests have become active within vegetation or structures to be removed. If an old nest has been

[118] KRRC submitted the CEQA support document to agencies in September 2017 and requested feedback by November 10, 2017.

[119] Bird nesting season identified by A. Henderson, CDFW, Environmental Scientist, pers. comm October 2017. Timing may be modified by CDFW based on nesting information collected in the Area of Analysis.

[120] Surveys distance and timing identified by CDFW on 29 September 2017.

documented, it shall be removed during the non-nesting season to discourage future use of the nest.

- If potential greater sandhill crane nesting habitat is present within 500 feet of Proposed Project activities, any potential nesting habitat within the 500-foot radius shall also be surveyed for the presence of active greater sandhill crane nests.
- For all raptors (other than eagles), inactive nests shall be considered for removal before the nesting seasons begin, to the greatest extent practicable. (This includes osprey nests within 0.75 mile of construction areas.) For those nests where access is difficult, traffic cones or other deterrents shall be placed in the nest platform to prevent nesting in the year of construction. All deterrents shall be removed as soon as possible after construction activity is ceased within the disturbance buffer (Table 3.5-7 below) for that species.
- The on-site or avian biologist approved by CDFW and USFWS shall be on site prior to and during the bird nesting season to reduce the potential for nesting as much as possible.
- If an active nest is observed for a non-special-status species that is not a raptor, then the on-site biologist may identify an appropriate buffer, considering ambient conditions and response of bird to existing conditions. If this nest is in a location where the Proposed Project would destroy the nest, the KRRC shall attempt to reschedule activities until the young fledge. If the KRRC has considered rescheduling activities and implemented the minimization measures described above (repeated surveys, on-site monitors, removal old non-active nests outside of the breeding season), CDFW shall be contacted to discuss further measures.
- If an active raptor or special-status bird nest is observed, a restriction buffer shall be established. This shall include consideration of noise effects and line-of-sight considerations. (Bald and golden eagle species-specific recommended measures are discussed below in Potential Impact 3.5-13 and Recommended Terrestrial Measure 11)
    - Table 3.5-7 lists the restriction buffer distances and timing for many common raptor species with potential to occur within or near construction areas, as provided by USFWS (Strassburger 2011). All restriction buffers for raptors shall follow the spatial buffers as identified in Table 3.5-7, and consultation with agencies shall occur prior to implementing the activity if: (a) construction activity is within the buffer distance, or (b) the species is not identified in Table 3.5-7.
    - Buffers for passerines not state or federally listed as candidate, threatened, or endangered shall be established by a qualified avian biologist approved by CDFW and USFWS.
    - No vegetation removal or construction activities shall occur within the disturbance buffer until the young have fledged, as determined by the qualified biologist. Monitoring in these cases shall include determining and reporting to CDFW and USFWS the ultimate fate of the nest.
- If an active special-status bird nest is observed where the Proposed Project would destroy the nest, this could be a significant effect and KRRC shall obtain approval by applicable agencies.
- Tracking of nesting birds shall be reported once a month to applicable agencies.

Table 3.5-7. Noise Disturbance Buffers and Seasonal Timing Restrictions for Nesting Raptors.

Species	Noise Disturbance Buffer (miles [feet])	Seasonal Timing Restriction
Bald eagle	1.00 mi (5,280 ft)	Jan 1–Aug 31
Golden eagle	1.00 mi (5,280 ft)	Jan 1–Aug 31
Northern goshawk	0.75 mi (3,960 ft)	March 1–Aug 15
Northern harrier	0.75 mi (3,960 ft)	April 1–Aug 15
Cooper's hawk	0.75 mi (3,960 ft)	March 15–Aug 31
Ferruginous hawk	1.00 mi (5,280 ft)	March 1–Aug 1
Red-tailed hawk	0.75 mi (3,960 ft)	March 15–Aug 15
Sharp-shinned hawk	0.75 mi (3,960 ft)	March 15–Aug 31
Swainson's hawk	0.75 mi (3,960 ft)	March 1–Aug 31
Turkey vulture	0.75 mi (3,960 ft)	May 1–Aug 15
Peregrine falcon	1.00 mi (5,280 ft)	Feb 1–Aug 31
Prairie falcon	0.75 mi (3,960 ft)	April 1–Aug 31
Merlin	0.75 mi (3,960 ft)	April 1–Aug 31
American kestrel	0.05 mi (300 feet)	April 1–Aug 15
Osprey	0.75 mi (3,960 ft)	April 1–Aug 31
Burrowing owl	0.25–0.75 mi (1,320–3,960 ft)	March 1–Aug 31
Flammulated owl	0.75 mi (3,960 ft)	April 1–Sept 30
Great horned owl	0.75 mi (3,960 ft)	Dec 1–Sept 30
Long-eared owl	0.75 mi (3,960 ft)	Feb 1–Aug 15
Northern saw-whet owl	0.75 mi (3,960 ft)	March 1–Aug 31
Short-eared owl	0.75 mi (3,960 ft)	March 1–Aug 1
Northern pygmy-owl	0.75 mi (3,960 ft)	April 1–Aug 1
Western screech-owl	0.75 mi (3,960 ft)	March 1–Aug 15
Barn owl	0.062–0.25 mi (330–1,320 ft)	Feb 1–Sept 15

Source: USFWS (Strassburger 2011)

Significance

Significant and unavoidable

Potential Impact 3.5-12 Effects on willow flycatcher from short-term construction-related noise and short-term and long-term habitat alterations.

In the short term, construction activities including, but not limited to, structure demolition, hatchery modifications (Section 2.7.6 *Hatchery Operations*), road and bridge upgrades (Appendix B: *Definite Plan – Appendix K*), and culvert improvements (Section 3.22.2.3 *Road Conditions*) could result in noise disturbance and habitat removal that may result in significant impacts on willow flycatcher. Significant impacts may result from direct mortality or physical harm to individuals; degradation of habitat or a change in habitat conditions that would result in physiological impairment or that may affect the ability to perform essential behaviors such as migration, feeding, or reproducing; or abandonment of active bird nests. As a result, habitat removal or disturbance during the bird nesting season has the potential to remove a nest directly and/or result in nest failure, which would be a significant impact. The Proposed Project does not include a significant amount of tree removal, but rather it is anticipated that habitat removal could occur if branches or small trees would need to be removed in order to upgrade bridges and roads. As a result, it is not anticipated that the quantity or quality of the habitat would be degraded, but rather the potential for direct or incidental harm from noise or removal of a nest in a branch, if present. There are few locations where modeled willow flycatcher habitat (discussed below) overlaps the Limits of Work. If activities occur in this area, the Proposed Project may cause nest abandonment due to construction noise or direct harm due to physical removal of vegetation, similarly to the impacts described in Potential Impact 3.5-10 for nesting birds. The Proposed Project includes construction activities at Copco Road Bridge over Jenny Creek, which is located in an area of known willow flycatcher use.

Willow flycatcher habitat has been modeled in areas along the Hydroelectric Reach and Middle Klamath River and reservoirs, and most of the habitat is predicted to occur along riverine habitat rather than reservoir habitats (Stermer et al. 2002). Under existing conditions, habitat modeling along the Klamath River between the California-Oregon state line and Cottonwood Creek (approximately 9 RM downstream of Iron Gate Dam) indicates that approximately 10 percent of habitat is suitable for the willow flycatcher (assuming a 0.1-mile buffer). Along reservoir shorelines, modeled suitable willow flycatcher habitat represents only 0.2 percent of existing conditions habitat; the few relatively small patches are located at the upstream-most end of Iron Gate Reservoir at Fall Creek and at Copco No. 1 Reservoir near the confluences of East Fork Beaver Creek and Deer Creek. This modeled willow flycatcher habitat did not identify suitable habitat at the confluence of Jenny Creek and Iron Gate Reservoir, even though willow flycatcher use has been documented at these locations. Under the Proposed Project, the distribution of suitable habitat along the newly formed Klamath River banks in the Hydroelectric Reach is expected to be similar to the relative amount of habitat that is currently present upstream and downstream of the reservoirs, and thus overall the amount of flycatcher habitat would be expected to increase.

Following drawdown and restoration of the reservoir area, the modeled existing riparian habitat located along Fall Creek, East Fork Beaver Creek, and Deer Creek would be expected to continue invertebrate production and thus serve as a resource for willow flycatcher foraging. Further, the riparian habitats supported along these creeks would expand toward the newly formed banks of the Klamath River. While the new riparian habitats are establishing, the existing habitat would continue to be present throughout the Hydroelectric Reach upstream of Copco No. 1 Reservoir and at the confluence of Fall Creek. As a result, the long-term effect of the Proposed Project on willow flycatcher habitat would be beneficial.

The Proposed Project includes components to avoid and minimize impacts including conducting a habitat evaluation to identify suitable habitat, and if it is determined that there would be impacts on the potential willow flycatcher habitat from Project implementation in areas where presence is uncertain or cannot be assumed, the KRRC will conduct protocol surveys for willow flycatcher in the spring of the year prior to drawdown, in coordination with resource agencies (Appendix B: *Definite Plan – Appendix J*). Also, when harvesting willow pole cuttings to support restoration activities, KRRC proposes to avoid areas where there is known habitat for willow flycatcher (Appendix B: *Definite Plan – Appendix H*).

While the Proposed Project avoidance and minimization measures would reduce the potential for short-term construction-related impacts on willow flycatcher within the Primary Area of Analysis, the aforementioned components need more specificity to ensure that short-term construction activities would not result in significant impacts on this special-status species or substantially interfere with movement and/or migration of wildlife species, or that any remaining potentially significant impacts are mitigated to the extent feasible. Implementation of the recommended measure below, developed in consultation with CDFW, would reduce potential short-term construction-related impacts on willow flycatcher to less than significant. KRRC also proposes that KRRC and the appropriate state or local agency would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be 'good citizens' of the communities in which projects are located and thus to comply, where possible, with state and local requirements.

It would be appropriate for the recommended terms and conditions relating to protection of willow flycatcher to include the Recommended Terrestrial Measure 10 below, which has been developed in consultation with CDFW. The Recommended Terrestrial Measure 10 includes components beyond those listed as part of the Proposed Project and would be necessary to reduce potential short-term construction related impacts on willow flycatcher to less than significant (see Recommended Terrestrial Measure 10). These components include conducting construction activities outside of the bird nesting season, protocol-level surveys in suitable habitat that have the potential to be affect to collect information on the number of flycatchers that may be affected by activities, establishing a no-construction buffer, and removing only the amount of vegetation necessary to implement the action and not affect the overall habitat quality of the patch. The recommended terrestrial measure is consistent with widely accepted professional best management practices for environmental protection which would reduce potential harm to the species; therefore, result in less than significant impacts due to the Proposed Project.

Overseeing development and implementation of recommended term and conditions relating to the willow flycatcher does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has initiated a process[121] to reach enforceable good citizen agreements with CDFW that will be finalized and implemented, at this time the recommended term and conditions are not finalized, and the State Water Board cannot require their implementation. Accordingly, while the State Water Board anticipates that implementation of the recommended term and conditions, including the Recommended Terrestrial Measures and any modifications developed through the FERC process that provide the same or better level of protection for willow flycatcher, would reduce impacts to less than significant, because the State Water Board cannot ensure implementation of the Recommended Terrestrial Measures, it is analyzing the associated impacts in this Draft EIR as significant and unavoidable.

[121] KRRC submitted the CEQA support document to agencies in September 2017 and requested feedback by November 10, 2017.

Recommended Terrestrial Measure 10 – Willow Flycatcher.

- As proposed by the KRRC, the KRRC shall conduct an assessment to identify potential suitable habitat for willow flycatcher in habitat that has the potential to be affected by the Proposed Project. The assessment would occur in the spring of the year prior to drawdown or before.
- Construction activities within suitable habitat or known willow flycatcher locations (e.g., Jenny Creek Bridge replacement activities) shall occur outside of the bird nesting season and habitat disturbance shall be minimized as much as possible. The on-site biologist (Recommended Terrestrial Measure 3) shall monitor to ensure that habitat removal includes only the amount necessary to implement the action and would not affect the overall habitat quality of the patch.
- If construction activities or habitat removal occurs in potentially suitable habitat during the bird nesting season, protocol-level surveys will be conducted prior to the construction activity or habitat removal, and if the willow flycatcher is documented within an area that has the potential to be affected, coordination with CDFW shall occur to identify an appropriate buffer to be implemented. Any impact resulting from the Proposed Project that would result in the mortality or physical harm or impairment of an individual willow flycatcher would be a significant impact. If activities would need to occur within the buffer, the KRRC shall implement any measures CDFW deems necessary. Report on the status of any willow flycatcher surveys once a month when surveys are conducted to applicable agencies.

Significance

Significant and unavoidable in the short term

Beneficial in the long term due to expansion of riparian habitat in the former location of Copco No. 1 and Iron Gate reservoirs

Potential Impact 3.5-13 Short-term impacts on bald and golden eagles from construction-related noise and nesting habitat alterations.

Short-term construction-related activities including, but not limited to, structure demolition, hatchery modifications (Section 2.7.6 *Hatchery Operations*), road and bridge upgrades (Appendix B: *Definite Plan – Appendix K*), and culvert improvements (Section 3.22.2.3 *Road Conditions*) could result in noise disturbance and habitat removal impacts on bald and golden eagles. Bald and golden eagles are protected by the Bald and Golden Eagle Protection Act that prohibits anyone without a permit to take alive or dead any part of a bald or golden eagle or their nest. Impacts on bald and golden eagles are similar to those described in Potential Impact 3.5-10 for nesting birds. 2018 eagle surveys documented two inactive bald eagle nests—one within 0.5 miles of Copco Reservoir and one located between 0.5–2 miles of Iron Gate Reservoir (S. Leonard, AECOM, Senior Water Resources Engineer, pers. comm, October 2018). Two active golden eagle nests were found within two miles of Copco No. 1 Reservoir and three inactive nests were documented within 2 miles of Iron Gate Reservoir (S. Leonard, AECOM, Senior Water Resources Engineer, pers. comm, October 2018). In May 2018, a golden eagle was observed at Copco No. 1 Reservoir perched on a slope on the northern shoreline, a pair was observed near a northern cove, and one was observed bathing in the shallow water (CDM Smith 2018c).

Bald eagle nesting trees are known to exist within or near proposed Lower Klamath Project construction areas. A bald eagle nest, active from 1986 to 1997, was located approximately two miles from Iron Gate Dam; a nest active from 1993 to 1997 was documented within 0.5 mile of Iron Gate Dam; and an active nest in 2002 was documented within two miles of Iron Gate Dam (Willy 2017, as cited in *Appendix B: Definite Plan*). As bald eagle nests have been previously documented nearby, and as bald eagles may use the same nests in multiple years, there is a potential for bald eagles to nest in these same sites (or locations in similar habitats) and be disturbed by Proposed Project noise. Noise disturbance may cause nest abandonment while physical removal of vegetation may result in direct harm. Construction activities that could result in noise and disturbance impacts on bald and golden eagles include dam demolition, clearing of access and haul roads, creating and using staging and disposal sites, and restoration activities. Project impacts on nesting eagles could occur if individuals are nesting (January 1 through August 31) while construction activities occur—powerhouse and dam removal activities would begin November 1 of the year prior to drawdown and continue through September of the drawdown year (Table 2.8-1). Without surveys to document nesting bald or golden eagles and buffers to prevent noise and habitat removal impacts, bald and golden eagles if present, would be displaced resulting in a failed nest or mortality to young, and this would be a significant short-term impact. (Potential impacts from the loss of reservoir habitat are addressed in Potential Impact 3.5-14 and potential impacts from the reduction in hatchery output are addressed in Potential Impact 3.5-25).

The Proposed Project includes components to avoid and minimize construction-related impacts on bald and golden eagles (Appendix B: *Definite Plan – Appendix J*) which include, but are not limited to, the components listed below.

- The following surveys were conducted for the Proposed Project.
    - Initial ground-based nest search survey in late January/early February 2018 and a second ground-based and aerial survey was conducted in June 2018 covering an area approximately two miles from construction and demolition sites and 0.5 mile from other areas within the Limits of Work including reservoir boundaries where significant demolition and construction activities would not be occurring. The 2018 results are detailed above. (Survey methods were based on established protocols including Jackman and Jenkins 2004 and Pagel et al. 2010).
- Future measures include the following:
    - Conducting an additional survey during the early nesting season of the year prior to drawdown to determine updated activity and to observe eagle activity patterns, to establish a baseline of normal behavior prior to construction.
    - Developing an Eagle Avoidance and Minimization Plan in coordination with the USFWS that identifies procedures and protocols for avoiding and minimizing impacts.
    - When possible, scheduling activities including clearing, cutting, and grubbing outside of the eagle nesting season (January 1 through August 31).
    - Applying a 0.5-mile restriction buffer if a nest is within two miles of the Limits of Work in coordination with resource agencies to ensure nests that are not disturbed. If an eagle nest is within the 0.5-mile buffer, then construction activities would be halted until coordination with resource agencies determine that construction can resume. The KRRC noted that if there are topographic or vegetative features that would block the eagle's line of site to the activity, the buffer could be reduced to 0.25 mile. A further narrowing of the buffer or

identification of specific activities that could be determined in coordination with the biological monitors and the USFWS, as long as the activities would not jeopardize nesting success.

While the Proposed Project avoidance and minimization measures would reduce the potential for short-term construction-related impacts on bald and golden eagles within the Primary Area of Analysis, the aforementioned components need more specificity to ensure that short-term construction activities would not result in significant impacts on bald an golden eagles or substantially interfere with their movement and/or migration, or that any remaining potentially significant impacts are mitigated to the extent feasible. Implementation of the recommended bald and golden eagle mitigation measure below, developed in consultation with CDFW and USFWS, would reduce potential short-term construction-related impacts on bald and golden eagles to less than significant. KRRC proposes that KRRC and the appropriate state or local agency would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be 'good citizens' of the communities in which projects are located and thus to comply, where possible, with state and local requirements.

It would be appropriate for the recommended terms and conditions relating to protection of bald and golden eagles to include Recommended Terrestrial Measure 11 below, which has been developed in consultation with CDFW and USFWS. This recommended terrestrial measure includes the following additional components beyond those listed as part of the Proposed Project:

- During the implementation of the 2018 eagle surveys, a two-mile survey area was established surrounding construction and demolition areas and a 0.5-mile survey area surrounding other areas such as reservoirs. Appendix J of the Definite Plan identifies aerial seeding within the reservoir footprint, and as a result the survey area shall reflect the modified noise disturbance areas around the reservoirs by expanding the surveys buffer around the reservoirs from 0.5 mile to one mile. (A minimum of a one-mile survey area is based on the one-mile buffer distance that would be applied if an active nest was present.)
- Consultation with resource agencies shall include both USFWS and CDFW, as the eagles are protected by the federal Bald and Golden Eagle Protection Act and the bald eagle is listed as a state endangered species.
- Nests shall be monitored within buffer zones.

Overseeing development and implementation of recommended term and conditions relating to bald and golden eagles does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has initiated a process[122] to reach enforceable good citizen agreements with USFWS and CDFW that will be finalized and implemented, at this time the recommended term and conditions are not finalized, and the State Water Board cannot require their implementation. Accordingly, while the State Water Board anticipates that implementation of the recommended term and conditions, including the Recommended Terrestrial Measures and any modifications developed through the FERC process that provide the same or better level of protection for special-status wildlife, would reduce impacts to less than significant, because the

[122] KRRC submitted the CEQA support document to agencies in September 2017 and requested feedback by November 10, 2017.

State Water Board cannot ensure implementation of the Recommended Terrestrial Measures, it is analyzing the associated impacts in this Draft EIR as significant and unavoidable.

Recommended Terrestrial Measure 11 – Bald and Golden Eagle.

- KRRC shall develop an Eagle Avoidance and Management Plan in coordination with USFWS and CDFW.
- A two-year survey for eagle use patterns shall be conducted prior to construction activities.
  - The first-year survey shall determine bird use patterns at any facilities to be removed or modified during the time of year most likely to detect bird usage (this was completed by KRRC in 2017).
  - The second-year survey shall include focused surveys (see below).
  - Surveys shall be conducted by a qualified avian biologist, approved by resource agencies (CDFW and USFWS).
- A focused survey (two site visits) shall be conducted in a single nesting season within two years prior to drawdown to document the presence of nests. These focused surveys shall identify eagle nests within one miles of disturbance areas within the Limits of Work, including but not limited to demolition areas where there may be any loud noise disturbance (e.g., helicopter or plane). The early nesting season survey shall occur at a time when eagles are most likely found at the nest sites, and the second survey shall occur later in the season and prior to the fledglings leaving the nest to confirm nesting activity. All observations shall be reported to CDFW using the California Bald Eagle Nesting Territory Survey Form (CDFW 2017d).
- Within two weeks prior to commencing construction or ground-disturbing activities, KRRC shall conduct at least one pre-construction survey within the survey area defined above.
- Wherever possible, clearing, cutting, and grubbing activities shall be conducted outside of the eagle nesting season (January 1 through August 31[123]).
- If active eagle nests are documented during the surveys, a one-mile[124] restriction buffer shall be established around the nest to ensure that nests are not disturbed. This buffer may be reduced in coordination with USFWS and CDFW, while taking into consideration components such as proposed activity, distance to activity, terrain, and line of site. For example, in coordination with agencies, if a nest is not within line-of-site, meaning that trees or topographic features physically block the eagle's view of construction activities, the buffer could be reduced to 0.25 miles. Further reduction of buffers or allowance of limited activity inside of buffers could occur in coordination with on-site biologist, CDFW, and the USFWS, while being consistent with the Eagle Avoidance and Minimization Plan, if it is determined that the activities shall not jeopardize nesting success.
- Nests within a one-mile buffer shall be monitored by an USFWS- and CDFW-approved biologist when there is a potential for noise disturbance, in order to

[123] Eagle breeding season of January 1 through August 31 identified by A. Henderson, CDFW, Environmental Scientist, pers. comm, November 2017

[124] Eagle nest restriction buffer of 1.0 mile identified by A. Henderson, CDFW, Environmental Scientist, pers. comm, November 2017

assess whether eagle activity patterns are normal, as compared with that observed during baseline surveys described above.

- If activities are anticipated to result in take under the Bald and Golden Eagle Protection Act, it would be considered a significant impact and KRRC will coordinate appropriate measures, including procurement of any necessary take permits, with USFWS and CDFW. Report on the status of bald and golden eagle surveys within one month of the survey to applicable agencies.

Significance

Significant and unavoidable in the short term

Potential Impact 3.5-14 Short- and long-term impacts on bats from construction noise and loss of roosting habitat.

In the short term, construction activities including, but not limited to, structure demolition, hatchery modifications (Section 2.7.6 *Hatchery Operations*), road and bridge upgrades (Appendix B: *Definite Plan – Appendix K*), and culvert improvements (Section 3.22.2.3 *Road Conditions*) could disturb bat roosts through construction noise, physical vibration, and direct removal of roosting habitat.

Structures in the Lower Klamath Project are providing habitat for small day roosts and large maternity colonies. Recent structure assessments and surveys in 2017 and 2018 identified roosts in 22 structures with the largest of colonies (between a few hundred and a few thousand individuals) observed thus far at the Copco No. 1 Dam - C12 Gatehouse, Copco No. 1 Diversion Tunnel, Vacant House #21601 (light yellow house), and Iron Gate Diversion Tunnel (Appendix B: *Definite Plan – Appendix J*; KRRC 2018a, and KRRC 2018b). (see Table 3.5-8).

Table 3.5-8. Evidence of Bat Use at Structures Based on June 2017 Reconnaissance and Available Information from 2018 surveys (Appendix B: *Definite Plan – Appendix J;* KRRC 2018a,b)

Building Name	Evidence of Bat Use
All bridges scheduled for removal or modification	No roosting bats
Copco No. 1 and No. 2 Dams and Facilities	
Schoolhouse	No
House 19038 (next to schoolhouse)	Yes – abundant guano in crawl space.
Vacant House 1 (tan)	Yes – small numbers of bats present under wood panels outside.
Vacant House 2 (blue)	Yes – small numbers of bats present under wood panels outside.
Vacant House 3 (yellow)	Yes – small numbers of bats present under wood panels outside.
Vacant House 3 (yellow)	Yes – large colony in garage behind wood window framing, whole structure is being heavily used.
Vacant House 4 (peach)	Yes – maternity colony between flashing & fascia board all around roof edge; pups present.
Cookhouse	Yes – bats present in awning over side door outside, no sign inside.
Bunkhouse	Yes – guano on bed. Night roosting suspected from

Building Name	Evidence of Bat Use
	staining around outside lighting.
Copco No. 1 Dam - C12 Gatehouse	Yes – abundant guano/staining on the inside and outside of the building; dead bat (Myotis spp.) found outside on windowsill. Documented a large maternity roost of >2,000 Myotis spp. inside structure.
Copco No. 1 Powerhouse	Yes – several dozen bats clustered on wall above Transformer 3781; abundant staining/guano on basement level. Follow-up surveys documented small numbers of roosting bats.
Copco No. 1 Diversion Tunnel (also referenced as Tunnel outside of Copco No. 1 Powerhouse)	Yes – several hundred bats observed during emergence
Copco No. 2 Diversion Dam	No
Vacant House #21601 (light yellow house)	Yes – ~200 bats roosting in attic.
Shed (next to power station)	None found in main portion of shed. Back area of building was inaccessible.
Vacant House (light blue)	Yes – dead bat found in bathroom sink. No guano/staining inside. Attic vents are closed. No points of entry found.
Tin Pumphouse (across from light blue house)	No
Tin Pumphouse at entrance to Copco Village	Yes – small amount of guano outside. Multiple points of entry. Inside inaccessible.
Copco No. 2 Powerhouse	Yes – many dead bats on ground level (on floor, in storage room, control room) and dead pups at bottom of stairs on lower level. More sign/activity found at ground level. Follow-up surveys documented small numbers of roosting bats.
Control Room at Copco No. 2 Powerhouse	Not inspected during reconnaissance survey.
Shop next to power station at Copco No. 2	Not inspected during reconnaissance survey.
Occupied House next to Vacant House 4	Not inspected during reconnaissance survey.
Equipment shed (in front of bunkhouse/cookhouse)	Not inspected during reconnaissance survey.
Waste storage/wood shop by gas pumps (near houses/bunkhouse/cookhouse)	Not inspected during reconnaissance survey.
Iron Gate Dam and Facilities	
Gatehouse for low-level outlet (upstream side of dam)	Yes – night roosting evidence outside. No sign found inside.
Iron Gate Diversion Tunnel (also referenced as Tunnel near Iron Gate Powerhouse)	Yes – several hundred bats observed during emergence.
Iron Gate Powerhouse Intake	Yes - from ground level, bats heard through grating below. Entry via open grate on outside. Two dead bats. Observed abundant guano on plastic sheeting on floor inside.
Iron Gate Emergency Spill Equipment Shed	No

Building Name	Evidence of Bat Use
Iron Gate Hydro Resources Office/Powerhouse	Yes – heavily used night roost by light fixture under stairwell (abundant staining on concrete wall). Sign of significant roost inside concrete shaft (heavy staining/guano). Confined space entry to bottom level of powerhouse, did not inspect.
Bathroom/Storage building near powerhouse	No
Spawning building	Yes – small amount of guano. Potential night roosting outside.
2 storage trailers (parked next to each other)	No
Barn/Garage at Iron Gate Village	Yes – bats present in rafters/ceiling; abundant amount of guano.
Residence 1 (occupied) blue/gray	No–inspected outside only; inside/attic not accessed.
Residence 2 (occupied) tan w/green roof	Yes – 15 bats present behind clock on back porch. Attic access likely through loose screen over vent. Outside inspection only; inside/attic not accessed.

Short-term impacts may occur from disturbing a maternity and/or hibernacula colony, including those possibly used by special-status bat species. Structure modifications or significant noise or vibrational disturbance occurring during the bat maternity season have the greatest potential to affect special-status bats. Maternity colonies may have high numbers of non-volant young (unable to fly) that may be directly or indirectly harmed or killed, resulting in impacts on individuals or a colony. A hibernaculum is a roost that bats use to overwinter, which provides suitable microclimates and allows bats to hibernate by slowing their metabolic rate to survive through low temperatures and low abundance of food. Disturbing a hibernacula roost may interrupt the metabolic rate and cause bats to use limited energy reserves. Impacting a maternity or hibernacula roost has the potential to result in direct impact on individuals and/or colonies and thus result in a significant short-term impact. Working outside of sensitive life history periods (i.e., maternity, hibernacula) and excluding bats from structures prior to construction or during times when bats would be less affected, would reduce the impact on bats.

Although impacting a maternity or hibernacula roost would be considered a significant impact, removal of night roosts used by a few individuals would not represent a significant impact on bats, as (1) structures would not be removed during the night when bats are present and thus no direct impact would occur, and (2) there are homes and other structures within a 15-mile radius (H.T. Harvey and Associates 2004) of the Limits of Work that may provide suitable night roosting habitat.

In the long term, removing maternity or hibernacula roosts has the potential to result in population-level impacts, as it is not known if the bats will relocate or if there is suitable habitat in the adjacent area to support these roosts. Removal of large maternity or hibernacula roosts would result in a significant long-term impact.

Without surveying to document roosting bats, conducting construction within limited operating periods that are least likely to overlap with sensitive bat life histories, and creation of successful replacement roost habitats, impacts on bat in the short term and long term would be significant, as described above.

The Proposed Project includes components to avoid and minimize both short- and long-term construction-related impacts and loss of habitat on roosting bats including, but not limited to, the components below (additional details are provided in Appendix B: *Definite Plan – Appendix* J.

- The following surveys were recently conducted or in progress for the Proposed Project.
    - A site reconnaissance daytime visual inspection (most sites surveyed in July 2017 and May 2018) and emergence surveys and acoustic monitoring surveys in June 2018. Hibernacula surveys conducted in February and March 2018 (Copco No. 1 and Copco No. 2 structures only due to limited access). Surveys to assess migration in spring occurred in April/May and in fall occurred in September/October 2018.
- Future measures include the following:
    - KRRC is also assessing nearby trees scheduled for removal.
    - Removing facilities that support maternity colonies outside of the bat roosting season (March 2–October 31) and removing facilities that support hibernacula roosts when it is determined to be unoccupied.
    - Excluding bats outside of the bat roosting period when feasible and conducting exclusion consistent with a Bat Exclusion Plan that would be provided to CDFW prior to implementing the exclusion method.
    - If a structure is to be removed and contains bats, the KRRC proposes coordinating with agencies to remove habitat at a time when it would have the least impact on bats.
    - For replacement bat habitat, the KRRC proposes giving preference to on-site and in-kind opportunities and retaining existing structures supporting roosts, to the extent practical. For facilities that cannot be retained, the KRRC will construct free-standing bat roosts prior to the removal of the existing facility; the replacement habitat will be informed by features at the structure that currently supports the bat roost(s). The KRRC proposes to develop success criteria in coordination with agencies and bat specialists, as appropriate.

While the Proposed Project avoidance and minimization measures would reduce the potential for short-term construction-related impacts on bats within the Primary Area of Analysis, the aforementioned components need more specificity to ensure that short-term construction activities would not result in significant impacts on special-status species or substantially interfere with movement and/or migration of wildlife species, or that any remaining potentially significant impacts are mitigated to the extent feasible. The recommended terrestrial measure below, developed in consultation with CDFW, include additional components beyond those listed as part of the Proposed Project and would be necessary to reduce potential short-term construction-related impacts on special-status to less than significant, as specifically discussed in the recommended terrestrial measure below. KRRC proposes that KRRC and the appropriate state or local agency would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be 'good citizens' of the communities in which projects are located and thus to comply, where possible, with state and local requirements.

It would be appropriate for the recommended terms and conditions relating to protection of bats to include Recommended Terrestrial Measure 12 below, which was developed in consultation with CDFW. This recommended terrestrial measure includes the following additional components: (1) the proposed two-year surveys shall be conducted within five years prior to drawdown; (2) an additional assessment of all structures should be reassessed to detect any changes in use and update baseline data to be as contemporary as possible when used as a comparison for monitoring the success of replacement habitat; (3) additional specificity associated with the timing and required weather conditions during exclusion or habitat removal when bats are present to prevent impacts on individuals; (4) definition of a CDFW-proposed breeding season that is less restrictive than the KRRC-proposed season allowing for additional flexibility; (5) definition of a CDFW-proposed hibernating season that is more restrictive than proposed; (6) definition of protection measures in the event that a few bats are documented during construction at locations where surveys did not previously document use—bats may be captured and released by a CDFW-approved bat biologist; (7) additional options for artificial bat roosts (e.g., bridge enhancement); and (8) specificity regarding monitoring success criteria for replacement roost structures.

Overseeing development and implementation of recommended term and conditions relating to bats does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has initiated a process[125] to reach enforceable good citizen agreements with CDFW that will be finalized and implemented, at this time the recommended term and conditions are not finalized, and the State Water Board cannot require their implementation. Accordingly, while the State Water Board anticipates that implementation of the recommended term and conditions, including the Recommended Terrestrial Measures and any modifications developed through the FERC process that provide the same or better level of protection for special-status bats, would reduce impacts to less than significant, because the State Water Board cannot ensure implementation of the Recommended Terrestrial Measures, it is analyzing the associated impacts in this Draft EIR as significant and unavoidable.

Recommended Terrestrial Measure 12 – Roosting Bats and Habitat.

- Surveys described below shall be conducted within five years prior to drawdown, and within one year prior to drawdown all structures shall be reassessed to detect any change to the roost (maternity and hibernacula).
- A qualified bat biologist shall conduct two years of bat surveys at the facilities to be removed or modified to determine bat use (species use, roost type [maternity, day, night, hibernacula]) using visual observation/emergence surveys to assess size of roost and using acoustic detectors to identify species (or species group if identification to species is not feasible) present at the roost. Surveys shall be conducted during the time of year most likely to detect bat use during the maternity and hibernacula season.
- If surveys indicate that a structure is utilized as a bat maternity roost, then removal or modification of the facility shall occur outside of the bat maternity season

[125] KRRC submitted the CEQA support document to agencies in September 2017 and requested feedback by November 10, 2017.

(March 1–September 15)[126]. If the facility is used as a winter hibernacula, then removal or modification of the facility shall occur outside of the hibernacula season (October 15–February 28)[127] or when it is determined to be unoccupied. These timeframes may be adjusted based on site-specific conditions, data collected on-site or in the region, and proposed activities, as determined by the qualified bat biologist and in consultation with CDFW.

- No direct or indirect disturbance (exclusion or demolition as discussed below) shall occur during the peak of the maternity season (April 15–August 31)[128].
- Consistent with the KRRC's proposed measure, humane bat exclusion methods to seal facility entry sites (e.g., blocking by netting or installing sonic bat deterrence equipment) may occur to prevent bat use in a structure during the demolition. A Bat Exclusion Plan to identify proposed exclusion methods shall be developed by the qualified bat biologist and approved by CDFW prior to initiation. Exclusion measures shall be put in place when bats are active and weather is fair outside between September 1 and October 15[129]. During this allowable period, these activities may occur when evening temperatures are greater than 45ºF and no more than 0.5 inch of rainfall is predicted within the following 24 hours. The sites shall be monitored to determine whether the exclusion was successful. Humane bat exclusion methods shall be conducted by, or under the supervision of, a qualified bat biologist with experience in conducting humane exclusions that holds a CDFW Scientific Collecting Permit for bat capture.
- If demolition occurs at a time when a structure is occupied by a maternity colony or hibernating colony and exclusion was deemed infeasible, a plan shall be developed (this could be part of the Bat Exclusion Plan) in coordination with a qualified bat biologist and approved by CDFW to carefully remove the occupied bat habitat at a time when it would have the least impact on bats present and in a manner that avoids bat injury and mortality. Demolition shall occur when bats are active and weather is fair outside between September 1 and October 15[129]. During this period, activities to remove the occupied habitat may occur when evening temperatures are greater than 45°F and no more than 0.5 inch of rainfall is predicted within the following 24 hours. During demolition activities, a qualified bat biologist shall be present on site.
- If an on-site biologist (Recommended Terrestrial Measure 3) conducts a daily pre-construction survey (Recommended Terrestrial Measure 7) of a structure previously assessed as not providing habitat for bats and finds a few bats (and confirmed neither a hibernacula or maternity colony), a qualified bat biologist with experience handling bats and approved by CDFW may capture and release the bat(s) at dusk during suitable weather (i.e., not raining, temperatures greater than 45°F).
- To reduce short-term and long-term impacts on bats from the permanent loss of maternity or hibernating roosting habitat, creation and/or enhancement of artificial

[126] Bat maternity season identified by K. Hubbard, CDFW Environmental Scientist, pers. comm., November 2017.
[127] Bat hibernating season identified by K. Hubbard, CDFW Environmental Scientist, pers. comm., November 2017.
[128] Peak maternity season identified by K. Hubbard, CDFW Environmental Scientist, pers. comm., November 2017.
[129] Humane exclusion period identified by K. Hubbard, CDFW Environmental Scientist, pers. comm., November 2017.

roosting habitat shall occur prior to the structures being removed. New artificial bat roosting habitat shall be designed to support equivalent roost (maternity, hibernacula) habitat, numbers, and species excluded from the demolished roosts, with the goal of meeting the success criteria defined below.

- o The total number of artificial bat roosts shall depend on the total number of facilities removed with maternity and hibernacula bat roosts. The size and design of artificial bat roosts shall be informed by the features of the removed structure and the type and size of roost; critical design elements shall include access, ventilation, and thermal conditions.
- o Artificial bat roosts may include, but are not limited, to enhancing bridges to support roosting habitat and constructing free-standing artificial bat roosts on- or off-site in consultation with bat specialists and the resource agencies. Preference shall be given to on-site and in-kind solutions; however, if artificial free-standing bat roosts are unlikely to remain into the foreseeable future (e.g., due to land ownership changing following completion of the Proposed Project), the placement of artificial bat roosts in off-site locations on publicly owned land (e.g., Horseshoe Ranch Wildlife Area) may be considered in coordination with agencies (CDFW).
- o Experienced contractors shall perform the installation of bat roosts. The artificial bat roosts shall meet the applicable specifications of Bats in American Bridges (Keeley and Tuttle 1999) and California Bat Mitigation Techniques, Solutions, and Effectiveness (H.T. Harvey and Associates 2004).
- o Post-construction monitoring of the mitigated enhanced or replacement bat roosts shall occur multiple times of the year and depend on the type of roost being created. At a minimum, roost surveys shall occur seasonally (four times per year). Monitoring surveys may include, but are not limited to, emergence surveys, acoustic monitoring, and guano observation.
- o Monitoring shall occur for at least five years or until the mitigation can be considered successful. At Year 3, artificial bat roosts meeting the success criteria (described below) may be eliminated from the monitoring. Criteria shall be considered successful through concurrence with CDFW or their designated representatives.
  - The mitigated enhanced and/or replacement bat roosts will be considered successful if the following occurs: (1) the mitigation roost provides the function(s) of the demolished roost (i.e., maternity, hibernacula) and (2) the roost is occupied by a similar composition of species and number of bats that were present in the demolished roost (H.T. Harvey and Associates 2004). If this standard is not met, KRRC shall coordinate with CDFW, as appropriate, to ascertain the potential need for further measures (e.g., modifications to the mitigation roost(s), additional monitoring).

- Report on the status of bat surveys, exclusion activities, and success criteria monitoring within one month of the survey to applicable agencies.

Significance

Significant and unavoidable for short-term construction-related impacts

Significant and unavoidable for long-term habitat removal

Potential Impact 3.5-15 Impacts on northern spotted owl and critical habitat from construction-related noise and habitat alterations.

Northern spotted owls can be disturbed by noise, visual, or physical disturbances. The noisiest construction activities are blasting and helicopters (it is uncertain if aerial seeding would be done by plane or helicopter). Blasting has a disturbance distance of approximately one mile and helicopter use has a disturbance distance approximately of 0.5 mile, whereas other activities (e.g., chainsaw use, heavy equipment) have disturbance distances of approximately 0.25 mile (Table 3.5-9); disturbance distances were developed in coordination with the Arcata USFWS office using an estimation of auditory and visual disturbance effects (USFWS 2006) as a basis.

Helicopters can also cause a downdraft that can affect owls and nests. Without an assessment to identify if suitable habitat or owl nests are present or establish no-activity buffers surrounding a known nest location, the Proposed Project would result in direct harm on northern spotted owl, which would be a significant impact.

Table 3.5-9. Disturbance Distances[1] for the Northern Spotted Owl During the Breeding Period.

Source of Noise	Disturbance Distance
Blasting	1 mile
Hauling on open roads	0.25 mile
Heavy equipment	0.25 mile
Rock crushing	0.25 mile
Helicopter—Type I[2]	0.5 mile
Aircraft—Fixed Wing	0.25 mile

[1] Noise distances were developed in coordination with the Arcata USFWS office using an estimation of auditory and visual disturbance effects (USFWS 2006) as a basis.

[2] Type I helicopters seat at least 16 people and have a minimum capacity of 2,300 kg (5,000 lbs). Both a CH 47 (Chinook) and UH 60 (Blackhawk) are Type I helicopters.

The Proposed Project includes an assessment to evaluate suitable habitat and known activity centers, and if suitable habitat is present, to conduct protocol-level surveys, and if owls are present, implement seasonal restriction (March 1–September 30), prevent aircraft flights within or at an elevation lower than 0.5 miles of suitable nesting and roosting habitat during the entire breeding season, unless protocol-level surveys identify no activity centers or it is determined in coordination with the USFWS that there would be no effect on the activity center, and not remove components of owl habitat during the removal of transmission or installation or removal of fencing activities. An assessment conducted by the KRRC determined that there are no existing northern spotted owl activity centers are located within the noise disturbance distance of the construction activities (Table 3.5-9) (Appendix B: *Definitive Plan – Appendix J*).

The closest spotted owl activity center to the Proposed Project is located approximately 1.7 miles southeast of Copco No. 1 Reservoir, which is outside of the blasting disturbance distance from dam removal activities. As the northern spotted owl typically nests from February through September and construction activity would begin prior to the start of the nesting season (Table 2.7-1, Section 2.7 *Proposed Project*), this noise and human presence would likely discourage northern spotted owls from initiating nesting near construction areas. Based on the Northern Spotted Owl Relative Habitat Suitability model output, there is no nesting or roosting habitat within 1 mile of the reservoirs and based on habitat and previously recorded nesting locations, protocol-level surveys were not recommended (R. Carey, USFWS, Supervisory Fish and Wildlife Biologist, pers. comm, July 2018). Any potential impacts are more likely to occur from disturbance during aerial seeding of reservoir areas than to occur as a result of structure (e.g., dam and powerhouse) removal activities.

Helicopters may be used during restoration activities. As critical habitat (discussed below) is present approximately 0.6 mile from Copco No. 1 Reservoir, the Proposed Project avoidance and minimization measure to prevent aircraft flights within or at an elevation lower than 0.5 miles of suitable nesting and roosting habitat during the entire breeding season, unless protocol-level surveys identify no activity centers or it is determined in coordination with the USFWS that there would be no effect on the activity center would ensure that any potential short-term construction-related impacts on northern spotted owl would be less than significant.

No impacts on critical habitat were identified. Northern spotted owl critical habitat is present approximately 0.6 mile southeast of Copco No. 1 Reservoir. Within a 3-mile buffer of Copco No. 1 and Copco No. 2 reservoirs, the critical habitat only makes up approximately 4 percent (2,400 acres) of the upland habitat in this area. USFWS critical habitat designation (USFWS 2012) includes the following Primary Constituent Elements, physical and biological features essential for the conservation of the species—forest stands in early, mid-, or late seral stages, as well as nesting and roosting, foraging, and dispersal habitat as described below (USFWS 2012). However, as no components of critical habitat would be removed or modified, no long-term impacts were assessed and no further analysis was conducted. (Removal of individual or small number of trees or other vegetation to support activities such as widening existing roads are not expected to rise to the level of habitat modification.)

Implementation of the Proposed Project avoidance and minimization measures, as discussed above, would result in a less than significant impact on the northern spotted owl.

<u>Significance</u>
No significant impact

Potential Impact 3.5-16 Effects on special-status amphibians and reptiles in riverine habitats from short-term high suspended sediment concentrations (SSCs) and flows and long-term changes in water quality.
The Proposed Project would result in the release of sediment from behind the dams, causing increased SSCs within the mainstem Klamath River downstream of the dams. The sediment behind the dams is more than 80 percent fine sediment (organics, silts, and clays), which are expected to remain suspended in the Klamath River flow as it moves downstream and out into the Pacific Ocean (see Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*). Modeling results indicate elevated SSCs (>1,000 mg/L) in early January of dam removal year 2 when Iron Gate and J.C. Boyle reservoirs begin drawdown and Copco No. 1 Reservoir enters the second phase of drawdown. Depending on the water year type (dry, median, wet), SSCs would peak in February between 7,100 mg/L and 13,600 mg/L, decrease but remain elevated (>1,000 mg/L) between March and June, remain greater than or equal to 100 mg/L in

June and July, and remain greater than or equal to 30 mg/L until December or July of the following year. In a wet-year scenario, a second pulse of SSC greater than 100 mg/L would occur the following November and December (see Section 3.2 Water Quality—Figures 3.2-12 and 3.2-13) (see additional detail in Section 3.2.5.2 *Suspended Sediments*). SSCs in excess of 1,000 mg/L would occur downstream of Iron Gate Dam on a timescale of weeks to months (see Table 3.2-2), as compared with similarly high SSCs (or total suspended solids [TSS]) that can occur in the Middle and Lower Klamath River during winter storm events on a timescale of days to weeks under existing conditions (see Appendix C, Section C.2.2). River flows would be expected to remain below the 10-year flood event of 11,000 cubic feet per second (cfs). Potential impacts as a result of these flows are discussed below.

SSCs are expected to be higher in locations closer to the point of origin of the sediment (i.e., Hydroelectric Reach and Middle Klamath River immediately downstream of Iron Gate Dam) and to decline in a downstream direction due to dilution from tributaries (Stillwater Sciences 2008, USBR 2012). Model results also indicate that dilution in the Middle and Lower Klamath River would decrease SSCs to 60–70 percent of their initial value downstream of Seiad Valley (RM 129.4) and to 40 percent of their initial value downstream of Orleans (~RM 58.9) (Section 3.2.5.2 *Suspended Sediments*).

Elevated SSCs have the potential to adversely affect or cause mortality of sensitive life stages of amphibians and reptiles occurring in the Hydroelectric Reach and the Middle and Lower Klamath River. According to Stillwater Sciences (2009), high SSCs from dam removal could result in a worst-case scenario of 100 percent mortality of all amphibian eggs deposited in the Lower Klamath River. However, the scope of this assessment did not include a detailed species-specific analysis of the timing of the increased SSCs and the life history attributes and habitat use of the potentially affected amphibians and reptiles.

Increased SSCs from dam removal have the potential to decrease food availability by affecting the growth and survival of food sources such as algae, diatoms, and macroinvertebrate populations. This indirect impact of increased SSCs would likely have some effect on all reptile and amphibian species using the Klamath River downstream of the dams. However, this indirect impact is not considered a substantial adverse effect due to the short duration and timing of the impact and the life history attributes of affected species, particularly the seasonality of their habitat use. The potential impacts of high SSCs on specific special-status amphibian and reptile species are discussed below.

Foothill Yellow-Legged Frog

Foothill yellow-legged frog, proposed as threatened under CESA, are known to occur in the lower reaches of the Klamath River, while only historical occurrences are known closer to the Proposed Project. Foothill yellow-legged frogs and egg masses have been observed in mid-June on the Lower Klamath River approximately 13 RM upstream of the estuary (M. Wikaira Yurok Tribe to Parker Thaler, pers. comm., January 2018). The species has also been documented on the Klamath River approximately 20 RM upstream of the estuary by Green Diamond in 1994 (CDFW 2017a) adjacent to Green Diamond lands. Historical occurrences in 1970 documented the frog closer to the Proposed Project approximately 50 RM downstream from Iron Gate Dam, and farther downstream in 1976 (CDFW 2017a). Targeted surveys by PacifiCorp in 2003 did not document the species in mainstem and tributary locations identified as the most likely to support foothill yellow-legged frogs, including Bogus Creek, approximately 0.2 RM downstream of Iron Gate Dam and Cottonwood Creek, approximately eight miles downstream of Iron Gate Dam (PacifiCorp 2004a). Borisenko and Hayes (1999) hypothesized that the absence of foothill yellow-legged frogs was due to poor water quality released from Iron Gate Reservoir and fluctuating water levels.

The absence of foothill yellow-legged frogs during PacifiCorp 2003 surveys supports the hypothesis that they are no longer present downstream of Iron Gate Dam. However, PacifiCorp (2004a) indicates that historical records of foothill yellow-legged frogs occurred in Jenny Creek (a tributary to Iron Gate Reservoir) and Cottonwood and Little Bogus creeks, located downstream of Iron Gate Dam. Although it is not known how common the species was before the construction of the Lower Klamath Project, the foothill yellow-legged frog may be affected by loss of river habitat, predation by the non-native bullfrog and other aquatic predators, and desiccation or scour of egg masses resulting from flow alterations (PacifiCorp 2004a). Limiting factors downstream of Iron Gate dam may be more associated with flow patterns than with water temperatures, as water temperature conditions may be sufficiently suitable to support the frog. Foothill yellow-legged frog breeding is typically triggered by warming water temperatures between 50 and 53.6ºF. Daily average water temperatures in the Klamath River downstream of Iron Gate Dam (~RM 192), near Seiad Valley (RM 132.7), and at Orleans (RM 58.9) indicate that generally by mid-May water temperatures are 50–53.6ºF, which would be suitably warm to trigger breeding (Figures C-3 and C-4, Appendix C). According to Lannoo (2005), the foothill yellow-legged frog typically breeds between late April and June. In California, egg masses have been found between April 22 and July 6, with an average of May 3 (Lannoo 2005). In the Trinity River, a major tributary to the Lower Klamath River, Ashton et al. (1998) found that foothill yellow-legged frogs lay eggs throughout a three month period of April to June. Eggs generally hatch within 5–37 days (AmphibiaWeb 2018).

Elevated flows and release of suspended sediments on the foothill yellow-legged aquatic stages were evaluated downstream of Iron Gate Dam. As discussed in additional detail in Section 3.2.5.2 *Suspended Sediments*, SSCs would peak in February and remain elevated between March and June downstream of Iron Gate Dam. Dilution in the Middle and Lower Klamath River would decrease SSCs to 40 percent downstream of Orleans (~RM 58.9) (Section 3.2.5.2 *Suspended Sediments*). The early period (late April) of the foothill yellow-legged frog egg laying season overlaps with elevated SCCs between March and June (see Table 3.2-2).

High SSCs could have a short-term significant impact on the foothill yellow-legged frog egg masses and tadpoles, if present. Silt has often been observed on the outer surfaces of egg masses, which may make the eggs less conspicuous and thereby possibly reducing predation by visual predators (Lannoo 2005). However, a study to evaluate the growth and survival of western toad tadpoles from initial pulses of 130 and 260 mg/L of suspended sediment documented slower growth rates and reduced survival to metamorphosis as a result of tadpoles consuming the sediment (Wood and Johnson 2009). Therefore, suspended sediment may result in mortality or harm to state-candidate-threatened foothill yellow-legged frogs through reduced survival and growth of egg masses and tadpoles, which would be a significant impact.

Although river flows during reservoir drawdown may result in short-term impacts on foothill yellow-legged frogs due to scour of egg masses or displacement of tadpoles (if these lifestages are present), drawdown flows would be expected to remain below the 10-year flood event[130] and so would not be a change from existing conditions. If high flows occur early in the foothill yellow-legged frog breeding season, it is possible that adults may avoid direct impacts of high flow and associated SSCs by delaying breeding (Gonsolin 2010, GANDA 2008).

Although survey data are limited for characterizing the distribution of foothill yellow-legged frog in the Klamath River, recent occurrences have been documented in the Lower Klamath River and tributaries, and presumably individuals have the potential to be present in the Middle Klamath River. Due to the listing status of the foothill yellow-legged frog (state Candidate Threatened), take of a single individual (including egg masses as described above) would result in a significant impact and would require approval by applicable agencies. Mitigation typically employed to reduce impacts was considered for this Proposed Project; however, the action of rescuing and relocating eggs is infeasible due to the low likelihood of locating eggs during high levels of turbidity. In the long term, it is anticipated that improved water quality (i.e., elimination of blue-green algae blooms and their associated toxins) and elimination of existing peeking flows as a result of the Proposed Project may enhance habitat for the species and reducing potential for scouring of egg masses.

Juvenile and adult foothill yellow-legged frogs are semi-terrestrial. Foothill yellow-legged frogs breed in rivers and spend a significant amount of time in adjacent riparian and wetland habitats, and in tributaries to mainstem rivers. As such, juveniles and adults would have the ability to avoid the short-term impacts of high SSCs by moving up-slope or up tributary channels during the reservoir drawdown period. Thus, high juvenile and adult mortality is not expected from high SSCs in the Hydroelectric Reach or the Middle or Lower Klamath River.

Pacific Tailed Frog and Southern Torrent Salamander

Both the Pacific tailed frog and southern torrent salamander live in high-gradient headwater stream habitat and have been documented in tributaries to the Lower Klamath River. These species would not be expected to occur in the Lower Klamath River itself. High flows and sediment released from behind the dams would be transported downstream within the Lower Klamath River mainstem, whereas tributaries would not experience elevated SSCs. Therefore, short-term SSCs in the Middle and Lower Klamath River are not expected to affect the Pacific tailed frog or southern torrent salamander.

Northern Red-Legged Frog

The northern red-legged frog breeds in still or low-velocity ponds, pools, side-channels, and wetlands in the coastal areas of the Lower Klamath Basin, generally within 12 miles of the river mouth. Northern red-legged frogs lay their eggs on aquatic or submersed herbaceous emergent vegetation. As their egg-laying habitat requires still water or very low flow, their breeding sites are typically more up-slope and disconnected from the Lower and Middle Klamath River. These breeding sites would only be connected with the Klamath River during extreme high-flow events, in which case egg masses would likely experience high rates of mortality. Adult northern red-legged frogs are mostly terrestrial and spend substantial time foraging in upland habitats. Thus, short-term high

[130] A 10-year flood event results in flows of 11,000 cfs.

flows and high SSCs in the Middle and Lower Klamath River are not expected to result in substantial negative effects on eggs, tadpoles, or adult northern red-legged frogs.

Western Pond Turtle

Western pond turtles in the Middle and Lower Klamath River and Hydroelectric Reach use the mainstem channel as well as side-channels, backwaters, and adjacent wetland and riparian habitat. They often move to off-channel habitats, such as oxbows, or uplands during high flow events.

Although the western pond turtle is considered an aquatic species, they are known to spend a considerable portion of their lives in upland habitats. They may travel across terrestrial habitats as much as 0.6 mile from aquatic habitat and radio-tracking studies have recorded individuals occurring on land for up to seven months out of each year (Bury and Germano 2008). Some animals may be active year-round, while others may enter terrestrial overwintering sites in October or November and reemerge in March or April (Bury and Germano 2008). Turtles from river and stream habitats often leave the watercourse in late fall and move up to 1,500 feet into upland habitats to overwinter (Bury and Germano 2008).

The increased flows and SSCs during reservoir drawdown could result in impacts on the western pond turtle if conditions cause turtles to move away from underwater refugia and thus become more vulnerable to predators, or if conditions diminish foraging opportunities. Increased SSCs following dam removal for 2 to 4 months depending on the water year type) would have a short-term but unsubstantial effect on this species' foraging and habitat use because of their ability to forage in, and escape to, adjacent upland habitat if needed. In addition, as discussed in Appendix C, Section C.2.2, elevated SSCs are natural during winter and spring in the Middle and Lower Klamath River and western pond turtles are adapted to these conditions. Other important habitat features, such as availability of basking sites, are not anticipated to be impacted by the short-term increase in flows and SSCs. Both adults and hatchlings that emerged the spring of dam removal year 2 (year of drawdown) may be present during these flows and affected by increased sediments. As western pond turtle eggs are laid in upland habitats, neither flows or SSCs would affect this life stage.

Significance

No significant impact for amphibians (Pacific tailed frog, southern torrent salamander, northern red-legged frog) and reptile (western pond turtle) populations due to short-term increases in SSCs or flows

Significant and unavoidable impact for individual foothill yellow-legged frog egg masses, if present, due to short-term increases in SSCs

Beneficial for all amphibian and reptiles due to long-term improved water quality

Potential Impact 3.5-17 Effects on benthic macroinvertebrates short-term dewatering and sedimentation and long-term alterations to habitat.

Impacts to benthic macroinvertebrates (BMIs) are anticipated on populations present in the reservoir footprint as a result of reservoir drawdown and drying of the habitat, and downstream of iron Gate Dam as a result of sediment transport and deposition. During reservoir drawdown, it is anticipated that the removal of reservoirs would result in mortality to invertebrates through desiccation, except in locations where tributaries continue to provide streamflow.

Dam removal would result in sedimentation downstream of the reservoirs in the Hydroelectric Reach and the Middle Klamath River, from Iron Gate Dam to approximately Cottonwood Creek (see also Potential Impact 3.11-5). In the short term, the Proposed Project could alter bedload sediment transport and deposition and affect BMIs (Reid and Anderson 2000, Orr et al. 2008). As a result, impacts on BMI would be most substantial between Iron Gate Dam and Willow Creek (about 4.5 river miles downstream of Iron Gate Dam), but extend to Cottonwood Creek (approximately eight RMs downstream of Iron Gate Dam) (see also Potential Impact 3.11-5). Impacts are expected to include physiological stress, reduced growth, and potentially mortality.

While a large proportion of the BMI population in the Hydroelectric Reach and in the Middle Klamath River downstream of Iron Gate Dam would be affected in the short term, BMI populations would be expected to recover quickly due to the many sources for recolonization (i.e., tributaries) and their rapid dispersion through drift or aerial movement of adults. In a summary of multiple dam removal studies, Foley et al. (2017) report that following dam removal, BMI abundance tends to increase downstream of a dam and species assemblages transition to resemble sites upstream of the former dam. Furthermore, some BMI species can double their population size in days to weeks, such that they quickly recover once the initial sediment pulse has passed. Full recovery of BMI communities is typically observed within a year following disturbance (Tsui and McCart 1981, Anderson et al. 1998). Tullos et al. (2014) found that BMI communities downstream of the Brownsville (Calapooia River, Oregon) and Savage Rapids (Rogue River, Oregon) dams resembled upstream control sites within a year after dam removal.

In the long term, the Proposed Project would restore connectivity among the Lower Klamath Basin, the Hydroelectric Reach and its tributaries, and the Upper Klamath Basin, and would rehabilitate and increase availability of riverine habitat within the Hydroelectric Reach. Increased habitat availability and improved habitat quality would be beneficial to BMI populations.

Additional information regarding sedimentation impacts and BMI analysis is provided in Section 3.3.4.10 *Benthic Macroinvertebrates* and Section 3.3.5.8 *Aquatic Resource Impacts*.

Significance

No significant impact in the short term

Beneficial in the long term

Potential Impact 3.5-18 Short-term impacts on amphibian and reptile in riverine habitats from sedimentation.

Dam removal would result in sedimentation downstream of the reservoirs in the Hydroelectric Reach and the Middle Klamath River, from Iron Gate Dam to approximately Cottonwood Creek, located approximately eight RM downstream of Iron Gate Dam (see also Potential Impact 3.11-5). These sediment inputs are expected to result in sand and finer bedload sediment transport and deposition in river reaches downstream of the reservoirs, which could fill riffle substrate in some areas, reducing localized habitat for the larval phases of amphibian species (e.g., Pacific giant salamander). Western pond turtle adults may move upland during the sediment release, and since their eggs are laid on land, this life stage would not be affected.

As discussed above in Potential Impact 3.5-16 (potential impacts due to short-term elevated SSCs), targeted foothill yellow-legged frog surveys by PacifiCorp in 2003 did not document the species in mainstem and tributary locations identified at as the most likely to support the foothill yellow-legged frog, including Bogus Creek located approximately 0.2 RM downstream of Iron Gate Dam and Cottonwood Creek located approximately eight miles downstream of Iron Gate Dam (PacifiCorp 2004a), and as a result no impacts are anticipated. If suspended sediment settles further downstream, and/or foothill yellow-legged frogs are present, the presence of settled fine silt in slow moving portions of the river reaches would not likely affect the adhesion of egg masses based on foothill yellow-legged frogs loosen algae and sediment that could enhance the ability of egg masses to adhere to the substrate (Rombough and Hayes 2005).

In the short term, these transient sediment deposits would be highly erodible during subsequent high flow events, leading to a short residence time (i.e., likely one year or less except during dry years) (see also Potential Impact 3.11-5). As a result, the impacts would be less than significant in the short term.

Significance

No significant impact in the short term

Potential Impact 3.5-19 Impacts on native amphibians from loss of reservoir habitat.

The loss of reservoir habitat will reduce lake and pond-type habitat that supports the non-native American bullfrog (PacifiCorp 2004a), which are known to prey upon and out-compete native amphibians (CDFW 2018b). The American bullfrog range includes Northern California (California Herps 2018a) and the species has been documented in the Primary Area of Analysis. PacifiCorp (2004a) noted that the bullfrogs were widely distributed and included reservoir habitats such as Iron Gate Reservoir, but also noted that breeding habitat was present in shallow and backwater habitats in low gradient reaches, located between the Copco No 1. Reservoir and the Oregon-California state line (PacifiCorp 2004a). Although removing reservoir habitat would reduce pond and lake-type habitat for the American bullfrog, suitable bullfrog habitat would remain on the Klamath River, and would including restored backwater and wetland habitat. Therefore, native amphibians would continue to experience similar predation effects as observed where species ranges overlap with the American bullfrog, as a result, there is no significant impact as a result of the Proposed Project.

Significance

No significant impact

Potential Impact 3.5-20 Short- and long-term impacts on western pond turtle and amphibians from reduced BMI populations.

Dam removal would result in sedimentation downstream of the reservoirs in the Hydroelectric Reach and the Middle Klamath River, from Iron Gate Dam to approximately Cottonwood Creek, located approximately eight RM downstream of Iron Gate Dam (see also Potential Impact 3.11-5). The period of greatest initial impact would occur during the months following drawdown where BMI production would likely decrease in the reach from Iron Gate Dam to approximately Cottonwood Creek, located approximately miles downstream of Iron Gate Dam. As discussed in Potential Impact 3.5-17, BMI populations would be expected to recover quickly because of the many sources for recolonization, their rapid dispersion through drift or aerial movement of adults, and ability to double their population size in days to weeks, and as a result, long-term impacts on foraging turtles from a short-term reduction in BMI sources would be less than significant. Further, western pond turtle do not exclusively rely upon BMIs in their diets. Turtles also forage on aquatic plants, frogs, crayfish, frogs, and fish. As a result of western pond turtle's diverse diet, and the presence of BMI sources in tributaries to the Hydroelectric Reach and Middle Klamath River, short-term impacts on foraging turtles from reduced BMI populations would be less than significant.

Special-status amphibians were considered for impacts from reduced BMI populations; however, no short-term or long-term impacts were identified. Foothill yellow-legged frogs were not documented during PacifiCorp (2004a) surveys in reaches downstream to Cottonwood Creek and are not anticipated to be present and affected by reduced BMI populations. Pacific tailed frog and southern torrent salamander habitat is not present in this reach, as they use high-gradient headwater stream habitat.

Significance

No significant impact

Potential Impact 3.5-21 Short- and long-term impacts on birds and bats from loss of aquatic reservoir and shoreline vegetative habitat.

Following dam removal, reservoir aquatic habitat would transition to wet or upland habitat depending on future hydrologic and physical (topographic) conditions. Following drawdown of the reservoirs, existing upland vegetation is expected to remain unchanged and contribute to successional processes on newly exposed areas. Surrounding the reservoirs, upland tree-dominant vegetation types include Montane Hardwood, Montane Hardwood-Conifer, and Juniper (Section 3.5.2.1 *Vegetation Communities*; Appendix G). Trees dominant in these vegetation types are native trees and drought tolerant; although some of the trees immediately adjacent to the reservoir may currently be benefiting from an elevated water table, lowering groundwater following reservoir drawdown it is not expected to result in a large die-off. In contrast, tree-dominated wet habitats surrounding the reservoir (i.e., Montane Riparian and Palustrine Forested Wetland [Section 3.5.2.1 *Vegetation Communities*; Appendix G]) may transition to upland and existing trees including Oregon ash and bigleaf maple may be impacted; they may turn to snags for perching, form cavities for nesting birds and bats, or ultimately fall to the ground to provide habitat for small mammals and insects which birds and bats may forage. The Proposed Project includes several actions to encourage rapid revegetation with native riparian species including trees as defined in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) which will ultimately provide for tall structure habitat adjacent to the water course to support nesting birds and bats, and provide cover for other wildlife species. (Additional information available above under Potential Impact 3.5-2).

Water birds that currently use the reservoirs seasonally during migration and/or for overwintering would be affected by the loss of this aquatic habitat for nesting, foraging, loafing (resting on the water), and roosting. The loss of aquatic reservoir habitat would also reduce foraging opportunities for fish-eating birds including bald eagle, osprey, merganser, cormorant, egret, and heron (including the great blue heron rookery documented at Copco No. 1 Reservoir (PacifiCorp 2004b). Historically, two bald eagle nests were documented near Copco No. 1 Reservoir: one within 0.5 mile in 2002, and a second within two miles, which was monitored between 1993 and 1997 (*Appendix B: Definite Plan – Appendix J*). Bald eagles are opportunistic foragers and hunt mainly for fish and waterfowl (Peterson 1986, Zeiner et al. 1990b); however, they will also feed on small mammals and other small vertebrates and carrion (Buehler 2000). During and following reservoir drawdown, eagles would likely consume a variety of live and dead mammals and birds present year-round; there may be also be an enhanced opportunity for eagles to consume stranded or dead fish as a result of the Proposed Project. Bald eagles would use riverine habitat, along with other fish-eating species, or other aquatic habitat outside the Proposed Project for foraging. The initial drawdown of the reservoirs may strand invertebrates or fish and provide short-term foraging opportunities for a variety of birds. In addition, there may be an increase in foraging opportunities for these species presented by the return of salmon to the riverine system that replaces the reservoirs.

Changes in food availability for birds such as dabbling ducks that consume aquatic vegetation and invertebrates would occur. For example, these species would use the river or other aquatic habitat outside the Proposed Project for foraging once the reservoirs are gone. Similarly, foraging over aquatic habitat by swifts and bats that feed on flying insects would be reduced; however, as discussed in Potential Impact 3.5-17, once BMI populations reestablish after drawdown, swifts and bats would be able to feed over riverine habitat. Although golden eagles will eat fish, they primarily feed on small to medium-sized mammals (e.g., rabbits, squirrels), and therefore, are unlikely to be substantially affected by the change in aquatic habitat.

It is anticipated that birds (e.g., ducks, eagles, swifts) and bats would continue to use the river for foraging, or would use other aquatic habitat outside of the terrestrial resource Primary Area of Analysis; therefore, impacts in both the short- and long-term would be less than significant.

Significance

No significant impact

Potential Impact 3.5-22 Short-term and long-term impacts on western pond turtle from loss of aquatic habitat.

In the short term, reservoir drawdown would affect shoreline habitat currently used by western pond turtle. The potential impacts on western pond turtle may occur from turtles being entrapped during sediment redistribution, change in temperature on overwintering turtles in reservoir sediment from drawdown, and entrapment in cracks and increased predation during migration over the reservoir footprints following drawdown. As Copco No. 2 Reservoir has not been documented to support western pond turtles and limited habitat is available (e.g., lack of basking areas); the analysis below focuses on Copco No. 1 and Iron Gate reservoirs.

The KRRC proposes to draw down reservoirs between January and March at a maximum drawdown rate of five feet per day (Table 2.7-1, Appendix B: *Definite Plan – Appendix H*). Exposing reservoir sediment to ambient air conditions during and following drawdown will change the temperature of the sediment (more solar exposure and colder nights and possible wind shear). Turtles overwintering in the sediment would then be subject to these changing temperature stresses. There is a potential for erosion and shallow slides to occur at locations currently along the reservoir rims and existing water surface elevations. At Copco No. 1 Reservoir in particular, diatomite (fine-grained sedimentary rock formed from consolidated diatomaceous earth) terrace deposits surround much of the shoreline and extend below the surface waters. These deposits would exhibit low shear strength and would likely be unstable, potentially resulting in shallow slides that could entrap juvenile and adult turtles. Following drawdown, juvenile and adult western pond turtles may be affected including those that may be overwintering in the sediment or are present in the reservoir; turtles overwintering or present on land would not be affected by the sediment redistribution. The KRRC identified the locations of overwintering aquatic habitat (i.e., reservoir levels two meters deep) based on bathymetry data (AECOM et al. 2017), and in considering proximity to suitable basking and nesting habitation locations identified by PacifiCorp (2004a), the locations where there is the highest potential for redistribution of sediment to affect turtles at Copco No. 1 Reservoir are the northern arm of the reservoir near Beaver Creek and at Iron Gate Reservoir in the southeast cove, north cove at Camp Creek, and at the confluence of Jenny Creek and Fall Creek (Figures 3.5-7 and 3.5-8).

These locations are also consistent with the locations where the majority of turtles were documented during the 2018 wildlife survey—most observations at Copco No. 1 Reservoir were northern Beaver Creek and Raymond Gulch coves and most observations at Iron Gate Reservoir were along the northern half of the reservoir (Mirror Cove and near Camp Creek and Jenny Creek) (CDM Smith 2018c).

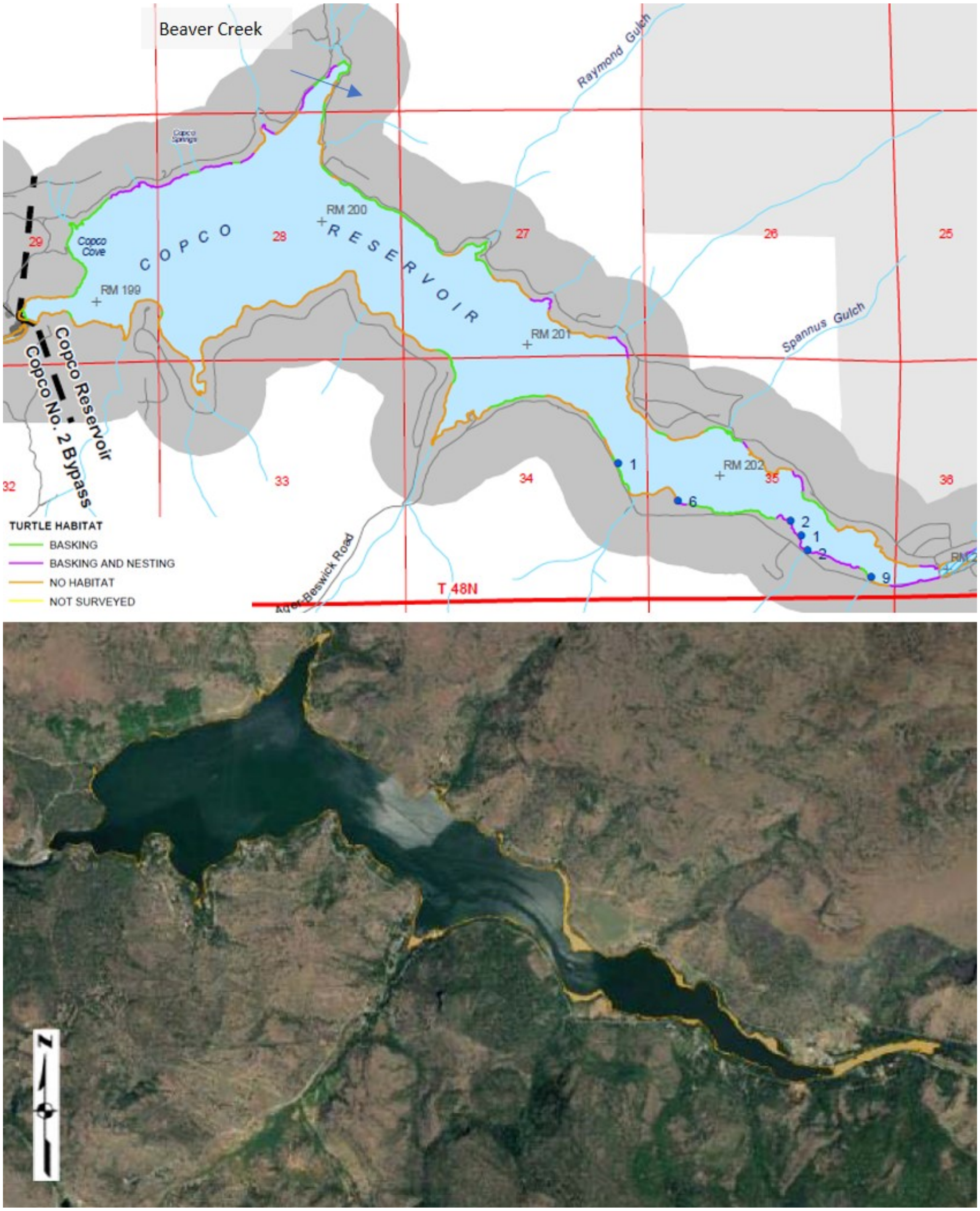

Figure 3.5-7. Western pond turtle suitable basking and nesting habitat in green and purple (top) and potential aquatic overwintering habitats in water depths of less than two meters in yellow (bottom) at Copco No. 1 Reservoir (PacifiCorp 2004a, AECOM et al. 2017).

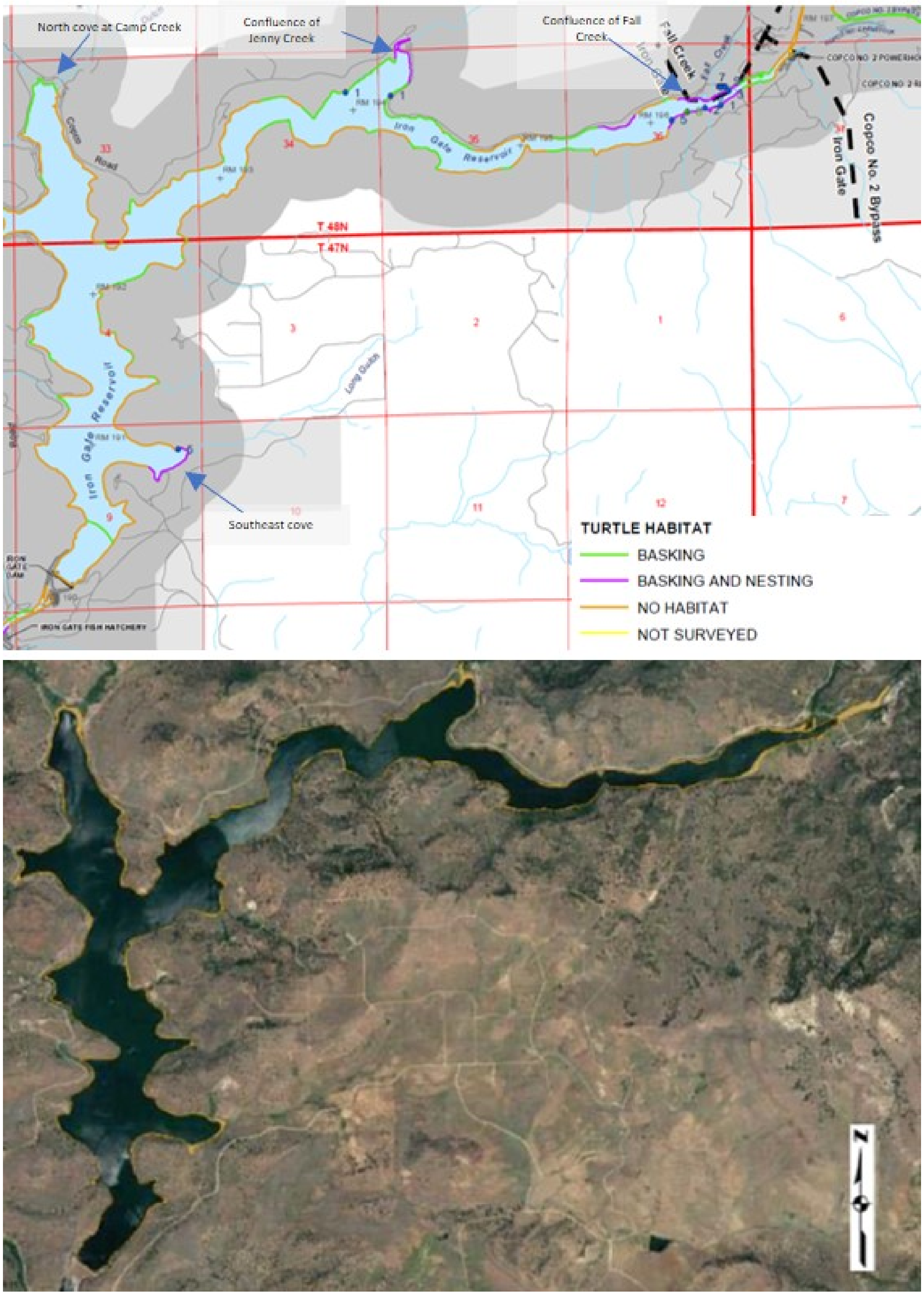

Figure 3.5-8. Western pond turtle suitable basking and nesting habitat in green and purple (top) and potential aquatic overwintering habitats in water depths of less than two meters in yellow (bottom) at Iron Gate Reservoir (PacifiCorp 2004a, AECOM et al. 2017).

There is also the potential for western pond turtles to be entrapped in cracks in the sediment deposits remaining in the reservoir footprints following drawdown (see also Potential Impact 3.11-5). The sediment underneath the reservoir is approximately 80 percent water by volume, and after the reservoir is drawn down, the sediment is expected to dry, decrease in thickness, and form cracks. The sediment drying process may result in turtles becoming trapped in the cracks and subject to predation.

Additionally, migrating hatchlings that emerge in spring could travel distances over barren soil to the river and may become entrapped in cracks formed by the mud and subject to increased predation from avian predators. Draining the reservoirs may also leave western pond turtles vulnerable to predation from a limited cover and forage (lack of vegetation and invertebrates along the shoreline) and subject to thermal stress. In one study, emerged hatchlings moved in short (<150 feet) increments, from one stop-over site to another until reaching aquatic habitat, and hatchlings tend to bury themselves under vegetation or debris and remain inactive for up to 21 days (Rosenberg and Swift 2010). With drying sediment and inability to hide under vegetation or debris, this may increase the potential of predation and thermal stress on hatchlings migrating during the spring of the drawdown year.

The western pond turtle population in the Klamath River has been estimated to be approximately 5 to 15 turtles per river mile (Bury 1995, as noted in PacifiCorp 2004). At this estimated density, turtles in Copco No. 1 Reservoir would number between 24 and 43 and in Iron Gate would be between 31 and 56. (The length of the reservoirs was calculated using the middle line of the reservoirs [i.e., Copco No. 1 Reservoir at 4.8 miles and Iron Gate Reservoir at 6.2 miles]). Available information regarding western pond turtle sightings is from 2002 and 2018 (PacifiCorp 2004a; K. Stenberg, Principal, CDM Smith, pers. comm., July 2018). Surveys conducted in Copco No. 1 Reservoir in 2002 documented 12 turtles while surveys in 2018 documented 31 to 36, which are similar to the anticipated density estimate. Surveys conducted in Iron Gate Reservoir in 2002 documented 8 turtles, while surveys in 2018 documented 17, which is lower than the anticipated density estimates. However, the goal of these surveys was not to document all individual turtles in the reservoirs, but rather note individuals basking; surveys were not inclusive of turtles underneath the water nor on land. As a result, the number of turtles documented using the reservoirs are likely an underestimate of the reservoir population.

It is not possible to predict how many hatchlings, juveniles, or adults would be affected in the short term by the potential effects described above. As discussed above, the survey results may not account for all turtles in the reservoir, as some may be underneath the water or on land. Also, an estimate of hatchlings is not possible as the age of the turtles is not known (females reach sexual maturity when they are about 8 to 10 years old]) and not all females lay eggs each year, while some may lay two clutches (California Herps 2018b). In addition, some turtles may be overwintering on land during the drawdown and not affected by sediment redistribution, and juveniles, adults, and hatchlings may not migrate over the dewatered reservoir, but rather may go around within more vegetated habitats or disperse into nearby tributaries.

Although exact numbers of take are not possible to identify, the impact on the reservoir population may be significant. Implementation of Mitigation Measure TER-4 (western pond turtle rescue after reservoir drawdown operations), developed in coordination with CDFW, would reduce these potential short-term impacts to less than significant.

Please note that in addition to requiring Mitigation Measure TER-4, the State Water Board has authority to review and approve any final plan developed to protect western pond turtle through its water quality certification under Clean Water Act Section 401. The State Water Board has issued a draft water quality certification[131] which sets forth monitoring and adaptive management requirements for an Amphibian and Reptile Management Plan as Condition 15.

In the long term, riverine habitat would continue to support the life history functions of western pond turtle. Although western pond turtles are documented throughout the Proposed Project reservoirs and along several reaches of the terrestrial resources Primary Area of Analysis, precise population data are not available. Thus, it is not possible to quantitatively assess population-level effects as a result of the Proposed Project. However, it is possible to assess the long-term potential for change in the amount of suitable habitat for supporting western pond turtle populations.

Based on the turtle nesting habitat suitability mapping conducted in 2002 for Copco No. 2 Bypass, Copco No. 1 Reservoir, and Iron Gate Reservoir, of the 40 miles of existing river and reservoir shoreline, only approximately 5.4 miles (13 percent) possess suitable nesting and basking habitat. An additional 13 miles (33 percent) have suitable basking habitat structure (i.e., logs, large rocks, or patches of persistent emergent vegetation), but do not possess high-quality potential nesting habitat because of steep slopes, developed shorelines, or shorelines with dense understory vegetation (PacifiCorp 2004a).

Under the Proposed Project, approximately 90 percent of the existing aquatic surface area would be removed. Aquatic habitat at the reservoirs would be converted to riverine, riparian, and upland habitat, depending on future hydrologic and physical (topographic) conditions. The existing surface area of the three California reservoirs is approximately 1,950 acres (Copco No. 1 Reservoir [1,000 acres], Iron Gate Reservoir [944 acres] [FERC 2007], Copco No. 2 Reservoir [6 acres]). Based on historical maps and aerial photos, PacifiCorp (2004a) estimated that approximately 227 acres of aquatic riverine habitat occurred historically (119 acres at Copco No. 1 Reservoir and 108 acres at Iron Gate Reservoir; Copco No. 2 Reservoir was not mapped). Although the overall surface area of aquatic habitat would decrease substantially (i.e., to approximately 195 acres) under the Proposed Project, the impact on western pond turtle would be more directly related to a change in the amount of shoreline habitat.

It is uncertain whether the number of western pond turtles currently present in the Hydroelectric Reach would allow for additional population growth or exceed the carrying capacity of habitat that becomes available along the restored riverbanks in the Hydroelectric Reach. Providing riverine habitat may support a higher density of turtles than that currently observed in the reservoirs. However, if the number of western pond turtles does exceed the carrying capacity of the available habitat along the restored riverbanks, it is uncertain whether they would then disperse into available habitat upstream or downstream along the Klamath River and/or upstream into tributaries that would then be present following the removal of the reservoirs. It is estimated that there are currently 18.4 miles of suitable nesting and basking habitat (PacifiCorp 2004a)

[131] The State Water Board's draft water quality certification is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 19, 2018).

surrounding Copco and Iron Gate reservoirs. Following the removal of the reservoirs, approximately 17.7 miles of mainstem and tributary reaches would be re-exposed in the reservoir footprints (see Reservoir Area Management Plan [Appendix B: *Definite Plan – Appendix H*]). Shoreline habitat would then be present on either side of the newly exposed mainstem channel and tributaries (i.e., approximately 17.7 miles), or providing approximately 35 miles of shoreline habitat. Following drawdown, it is anticipated that river flow through the area previously occupied by the Copco No. 1 Reservoir would meander and provide wetland/riparian habitat for turtles, while the river channel in Iron Gate Reservoir would be narrower, with historical channels associated with Jenny Creek and the Camp, Scotch, Dutch creek systems establishing riparian communities (AECOM et al. 2017). Although it is uncertain how much of the newly created mainstem and tributary shoreline habitat would be suitable for western pond turtle, the proposed habitat restoration in these areas would also create and enhance habitat for western pond turtle. The proposed habitat restoration is designed to slow water velocities along the riverbanks and thus has the potential to create backwater and basking habitat used by turtles. Proposed habitat restoration components include manually creating connectivity to tributaries, incorporating floodplain habitat features (e.g., wetlands, swales, side channels), creating shoreline complexity to slow water velocities, and placing large wood habitat features (see Reservoir Area Management Plan [Appendix B: *Definite Plan – Appendix H*]).

For context, the Lower Klamath Project reservoirs represent a small amount of the available open water/shoreline habitat in the Klamath Basin. While quantified information about suitable shoreline habitat in the upper basin is not available, the existing surface area of the Lower Klamath Project reservoirs is approximately 1,950 acres, which is relatively small when compared with the large open water areas and wetland complexes of Upper Klamath Lake (approximately 77,000 acres), Tule Lake (approximately 13,000 acres), or Lower Klamath Lake (approximately 22,000 acres of which approximately 2,200 acres are permanently flooded). Thus, population-level adverse effects to turtles would not be anticipated in the Klamath Basin due to the loss of aquatic reservoir habitat under the Proposed Project.

As a result of the restored Klamath River shoreline within the Hydroelectric Reach, including specific habitat restoration elements that would benefit western pond turtles (e.g., wetlands, swales, side channels) and a relatively small overall change in reservoir habitat throughout the Klamath Basin, there would be a less than significant long-term impact of the Proposed Project on western pond turtles.

Mitigation Measure TER-4 Western Pond Turtle Rescue After Reservoir Drawdown Operations.

Prior to implementing reservoir drawdown, KRRC shall develop a Western Pond Turtle Rescue and Relocation Plan in coordination with applicable agencies to identify a means of relocating as many turtles as feasible along the reservoir shoreline, assuming conditions are safe for all personnel. It is understood that not all turtles will be found, and not all turtles seen will be able to be captured and relocated. The goal of the plan shall be to apply a good-faith effort to reduce the number of turtles that are subject to mortality such that there will not be a significant impact on Western Pond turtles. The plan shall identify the following components:

- survey timing to cover multiple life stages (adults, overwintering adults, emerging hatchlings) present between initial reservoir drawdown and emergence;

- survey periodicity, focusing observations during periods of highest likelihood of observing these life stages—surveys may be considered complete after an identified number of surveys (e.g., three) does not detect turtles;
- survey locations that focus on suitable nesting habitat and locations where high numbers of turtles were documented during the general wildlife surveys (e.g., Copco Reservoir near Beaver Creek Raymond Gulch coves and at Iron Gate Reservoir in the southeast cove, north cove near Camp Creek, and at the confluence of Jenny Creek and Fall Creek);
- relocation areas in suitable habitat (that provide cover and food resources), which may include lower reaches of tributaries to the Klamath River;
- survey methodology—as nests and young are difficult to locate, an approach of using a trained dog to identify nests should be considered; and
- reporting of survey results within 60 days of the completion of surveys to applicable agencies and the State Water Resources Control Board.

Significance

No significant impact in the short term with mitigation

No significant impact in the long term with mitigation

Potential Impact 3.5-23 Long-term effects on deer from alterations to winter range habitat.

At Copco No. 1 and Iron Gate reservoirs, there are approximately 1,400 acres of inundated land that would become upland habitat (PacifiCorp 2004a). Under the Proposed Project, removing Iron Gate and Copco No. 1 reservoirs would not impact migratory wildlife corridors for deer nor impact deer wintering areas as identified in the Siskiyou County General Plan (Siskiyou County 1980, n.d.); rather the Proposed Project would increase the number of available acres of habitat within critical deer winter range in the long term, benefiting deer by expanding winter range habitat (Hamilton 2011).

Significance

Beneficial in the long term

Potential Impact 3.5-24 Effects on terrestrial species from herbicide use during reservoir restoration activities.

As part of the Proposed Project, the KRRC proposes initiating invasive plant control prior to dam removal year 1, continuing through the plant establishment period (post-dam removal year 1) until post-dam removal year 5 or until the vegetation restoration criteria have been met. The focus areas include newly exposed areas of the reservoir footprints and upland areas. Chemical herbicides would be used as a last resort when all other methods (e.g., manual weed pulling, mowing or cutting, tilling and disking, grazing, solarization) prove to be ineffective (Appendix B: *Appendix H – Reservoir Area Management Plan*).

The KRRC proposes to only use herbicides that have been approved for use by the BLM, CDFW, RWQCB, USFWS, and NMFS and herbicides would be applied by hand either by brushing (stumps and cut stems), wicking and/or spraying by a certified applicator and in accordance with all applicable laws and regulations. Because the herbicide application would be targeted to populations of invasive plants and applied in a very select manner, there would be no significant short-term impacts to special-status plants. There would likely be long-term beneficial effects to rare natural communities, wetlands and riparian vegetation as habitat conditions would be improved by reducing competition from invasive species.

Although the Reservoir Area Restoration Plan (Appendix B: *Definite Plan – Appendix H*) does not identify the types of herbicides that would be used, the KRRC has evaluated several herbicides, and is recommending glyphosate as the primary herbicide to control most of the invasive plant species (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., September 2018). Glyphosate may be formulated with surfactants to increase their efficacy, and in some cases, toxicity data have indicated that surfactants added to glyphosate are more toxic than glyphosate itself. For example, a Syracuse Environmental Research Associates (SERA 2002) study to evaluate effects of surfactants on the toxicity of glyphosate, noted a major qualitative difference between the effect of glyphosate and glyphosate formulations with a polyethoxylated tallow amine surfactant (used in Roundup) on aquatic and terrestrial organisms. However, a study conducted by the USDA-FS found no evidence that a nonylphenol ethoxylate-based surfactant lead to any level of concern for terrestrial wildlife (Bakke 2003, as cited in CINWECC 2004). Effects of the commonly used glyphosate and glyphosate-based herbicides with surfactant additives are analyzed below.

- Studies and assessments of glyphosate show that ecological risks for focused, short-term eradication efforts are small (Monheit 2003).
- While highly toxic to plants, glyphosate is non-toxic to animals (Williams et al. 2000, as cited in Monheit 2003).
- Glyphosate is poorly absorbed by the digestive track and is excreted essentially unmetabolized (Cornell University EXTOXNET database, Williams et al. 2000, both as cited in Monheit 2003).
- There is no evidence indicating that glyphosate is an immunotoxicant, neurotoxicant, or endocrine disruptor (SERA 2002, as cited in Monheit 2003).
- At typical application rates, none of the acute scenarios studied presented unacceptable risks to wildlife, including predatory birds consuming small mammals (Bautista 2007).

Raptors and terrestrial mammals prey mostly on small mammals and fish[132], and it is plausible that there is a potential risk to the prey species from direct or indirect application of herbicides. However, potential short-term and long-term impacts to raptors would be less than significant because KRRC proposes to (a) only apply herbicides approved by applicable agencies, (b) only apply when it is the most effective control method, (c) only apply by hand and by a certified applicator and in accordance with all applicable laws and regulations, and (d) would not target plants that provide habitat for raptor prey.

Special-status invertebrates were considered, and these invertebrates include pollinators such as the western bumblebee, which is a USDA Forest Service special-status species. There are no USDA Forest Service lands within the Limits of Work where herbicides may be applied, and thus no nexus to evaluate a USDA Forest Service species.

[132] Northern spotted owls prey primarily on small mammals (e.g., mice, voles), golden eagles primarily prey on birds, reptiles, and insects, and bald eagles and osprey primarily prey on fish.

However, potential impacts on pollinators would be less than significant because KRRC proposes to (a) only apply herbicides approved by applicable agencies, (b) only apply when it is the most effective control method, and (c) only apply by hand and by a certified applicator and in accordance with all applicable laws and regulations. As a result, no population-level impacts are anticipated.

Significance

No significant impacts in the short term on special-status plants and wildlife

Beneficial in the long term for rare natural communities, wetlands, and riparian vegetation

Potential Impact 3.5-25 Effects on wildlife from increased habitat for salmonids and changes in hatchery production.

Special-status wildlife such as bald eagle, Barrow's goldeneye, common loon, and western pond turtle may forage on out-migrating natural and hatchery-produced salmonids and/or on returning adult carcasses. The Proposed Project includes continued operation of Iron Gate Hatchery (IGH) and reopening of Fall Creek Hatchery (FCH)[133] for eight years following dam removal.

As discussed in Section 2.7.6 *Hatchery Operations* and Section 3.3.5.6 *Fish Hatcheries*, the total production goals for steelhead and fall-run Chinook salmon at Iron Gate Hatchery would be reduced from the current goal[134], and goals for coho yearling production would remain the same for eight years following dam removal. No data are available to accurately estimate the number of naturally produced smolts in the watershed in comparison with hatchery production, but based on adult returns (Section 3.3.2 [Aquatic Resources] Environmental Setting), hatchery-origin out-migrating fall-run Chinook salmon yearlings and smolts currently comprise approximately 35 percent of all fall-run Chinook salmon smolts outmigrating in the mainstem Klamath River. Under the Proposed Project (Potential Impact 3.3-7) hatchery production of fall-run Chinook salmon would be reduced by around 43 relative to current production (2005 through 2018) for eight years following dam removal. There would be no reduction in smolt outmigration relative to current levels for coho salmon for eight years following dam removal, and no reduction in steelhead (since no steelhead have been released since 2012).

For the first eight years following dam removal, the effect of hatchery production on terrestrial resources would be similar to current conditions. Once hatchery production is ceased (i.e., post-dam removal year 8), the hatchery fish would continue in the system for the next few years (see Section 3.3.5.6 *Fish Hatcheries*). However, in the year of dam removal (i.e., Year 2), both hatchery and natural-origin adults for all species would have access to new habitat for spawning, and thus production from Chinook salmon in new habitat would occur in Year 3 and coho and steelhead in Year 4.

[133] Fall Creek Hatchery ceased fish production in 2003.

[134] Goals at Iron Gate Hatchery for fall-run Chinook salmon yearlings would be reduced by approximately 87 percent, goals for fall-run Chinook salmon smolts reduced by approximately 33 percent, goals for steelhead would be reduced by 100 percent (no steelhead have been released since 2012 steelhead production is not a part of the Proposed Project)

Overall, the Proposed Project would open access to additional habitat for fish spawning, production, and migration and would increase prey and overall nutrient distribution for wildlife (see Section 3.3.5.9 *Aquatic Resource Impacts*). It is anticipated that juvenile fish production would increase as early as dam removal Year 3, and an increase in adult returns as soon as dam removal Year 4 (when the first progeny of adults using newly accessible habitat would return). Special-status bald eagle, Barrow's goldeneye, common loon, and western pond turtle forage on a variety of prey, including fish, and increasing juvenile and adult fish in the Klamath River system would result in an overall beneficial effect on these special-status wildlife.

Significance
Beneficial

Potential Impact 3.5-26 Impacts on special-status wildlife from Bogus Creek flow diversions.
Under the Proposed Project, up to 8.75 cfs of water would be diverted from Bogus Creek to operate Iron Gate Hatchery for eight years (through post-dam-removal Year 7), as described in Section 2.7.6 *Hatchery Operations*. Seasonal diversions would range from zero cfs during the summer (June through September), to 6.5 cfs during fall (October and November), 8.75 cfs during winter (December), 3.75 cfs during the late winter (January through March), and 8.25 cfs during spring (April through May). The precise diversion location is not proposed at this time, but it is anticipated to be within Bogus Creek less than 1,000 feet upstream from the confluence with the Klamath River. This would result in a maximum 1,000-foot bypass reach in lower Bogus Creek, which would experience lower fall, winter, and spring flows than occur under existing conditions.

Flow diversions have the potential to affect aquatic amphibians and reptiles, if present. Based on PacifiCorp surveys in 2002 and 2003 throughout the lower 492 feet and lower 0.5 mile of Bogus Creek, respectively, no special-status amphibians or reptiles were documented. Results specifically noted that no special-status foothill yellow-legged frogs or Pacific tailed frogs were present. Non-special-status species including common garter snake and fence lizards were observed during these surveys.

The proposed lack of diversions during June through September, and the proposal to operate the hatchery diversion to maintain a minimum of 50 percent of the instream flow in the creek at the point of diversion, means that flow-related adverse impacts on special-status wildlife in the Bogus Creek bypass reach, if they are present, are unlikely to occur. The KRRC also proposes to coordinate with NMFS and CDFW to assess conditions in Bogus Creek and to minimize the potential effects of Bogus Creek diversions on Coho salmon and their critical habitat (Section 2.7.6 *Hatchery Operations*). If sufficient water is maintained in the channel to support anadromous fish passage, then habitat would also be suitable for any special-status wildlife that are present.

However, based on the potential for low flows (less than 4.5 cfs) in the Bogus Creek bypass reach during some years, and the uncertain commitment under the Proposed Project to ensure flows to protect anadromous salmon volitional migration, there could be significant flow-related impacts to any special-status wildlife that are present. Mitigation Measure AQR-3 is included in this EIR (Section 3.3.5 *Potential Impact 3.3-23*) to ensure that the minimum flow requirement for anadromous fish species is released, and this would also provide assurance of suitable habitat for special-status amphibians and reptiles in the Bogus Creek bypass reach, if they are present. Implementation of Mitigation Measure AQR-3 would reduce potential impacts to less than significant.

Significance
No significant impact with mitigation

Potential Impact 3.5-27 Impacts on special-status wildlife from Fall Creek flow diversions.
Under the Proposed Project, up to 9.24 cfs of water would be diverted from Fall Creek to operate Fall Creek Hatchery for eight years (through post-dam-removal Year 7), as described in Section 2.7.6 *Hatchery Operations*. Seasonal diversions would range from 0.58 cfs during June, to 8.48 cfs during October, 9.24 cfs during November, and less than 2 cfs during the spring (February through May) (Section 2.7.6 *Hatchery Operations*). In addition, the City of Yreka maintains a water right to divert up to 15 cfs from Fall Creek for municipal purposes (City of Yreka 2012).

The City of Yreka is required to bypass a minimum flow of 15 cfs or the natural flow of Fall Creek, whenever the natural flow is less than 15 cfs. The Fall Creek Hatchery diversion and return flow points would occur between the City of Yreka water supply intake and the City's compliance point for the Fall Creek minimum flow, which is at the Fall Creek USGS gage (USGS 11512000). Between the Fall Creek Hatchery diversion and return flow points, the flow remaining in Fall Creek after the diversions for the City of Yreka and the Fall Creek Hatchery would usually be greater than 15.0 cfs, but it could occasionally be slightly less than 15.0 cfs in late summer to early fall (i.e., mid-July to mid-September) when Fall Creek flows reach a minimum (Figure 2.7-13). However, the flow downstream of the hatchery return flow would be generally similar to the flow under existing conditions and a substantial reduction in instream flows is not anticipated due to operation of Fall Creek Hatchery.

Surveys conducted at Fall Creek by PacifiCorp (2004a) documented northern sagebrush lizard (BLM sensitive) at Lower Fall Creek Falls and western pond turtle in a ponded wetland area that was created by a beaver pond near Iron Gate Reservoir. Non-special-status species documented include Pacific chorus frog, Pacific giant salamander larvae above and below Fall Creek diversion dam, western fence lizard, terrestrial garter snake, and common kingsnake. Mammals observed included bobcat and deer. As the Proposed Project would maintain approximately 15 cfs or greater flows in Fall Creek, there would be no impact to special-status wildlife compared to existing conditions.

Significance
No significant impact

Potential Impact 3.5-28 Impacts on sensitive habitats and special-status terrestrial wildlife and plant species from construction activities on Parcel B lands.
The Secondary Area of Analysis was used to evaluate potential impacts on sensitive habitats and special-status species on Parcel B lands. As discussed in Section 2.7-10 *Land Disposition and Transfer*, as part of the Proposed Project, Parcel B lands would be transferred to the states (i.e., California, Oregon), as applicable, or to a designated third-party transferee, following dam removal. The outcome of the future Parcel B land transfer is speculative with regard to land use; while the lands would be managed for the public interest, this could include open space, active wetland and riverine restoration, river-based recreation, grazing, and potentially others.

It is likely that there would be at least some construction for recreation facilities, active restoration, fencing, trail-building, or other land management activities. To the extent there are construction activities, these could involve the same types of potential short-term impacts to sensitive habitats and to special-status terrestrial wildlife and plant species as described in Section 3.5.5.1 *Vegetation Communities*, 3.5.5.2 *Culturally Significant Species*, and Section 3.5.5.3 *Special-status Species and Rare Natural Communities*. Future land use activities that involve active wetland and riverine restoration would be likely to result in long-term benefits to sensitive habitats and special-status terrestrial wildlife and plant species within the Secondary Area of Analysis. The special-status species that have the potential to occur within the Secondary Area of Analysis would be a subset of the species evaluated for the Primary Area of Analysis (Table 3.5-4 and 3.5-5), since the Secondary Area of Analysis is proximal to a portion of the Primary Area of Analysis. In the long term, if managed grazing activities were to occur beyond the level occurring under existing conditions, this could result in reduced habitat diversity and erosion-related significant impacts on special-status species, vegetation communities, and wetlands within the Secondary Area of Analysis.

To the extent there are construction activities under future land uses, it would be appropriate to implement the terms and conditions recommended to FERC relating to protection of sensitive habitats and special-status species and to include measures that provide the same or better level of protection for sensitive habitats and special-status terrestrial wildlife and plant species as the measures specified in Mitigation Measures WQ-1 and TER-1 through TER-4, and Recommended Terrestrial Measures 1 through 13, as modified for construction involved in the particular future land use activity or activities that result from the transfer of Parcel B lands. These measures represent protection under a broad range of large and small construction projects, both in-water and in the dry, and are likely to cover the range of construction activities that would support the various public land uses anticipated under the KHSA. If implemented as part of construction activities under future land uses, these measures would reduce impacts to less than significant. However, because the State Water Board cannot ensure implementation of these future measures, it is analyzing the impact in this Draft EIR as significant and unavoidable.

Significance
Significant and unavoidable

3.5.5.4 Wildlife Corridors and Habitat Connectivity

Potential Impact 3.5-29 Long-term effects on wildlife from alteration of wildlife movement corridors.
Removal of the Lower Klamath Project reservoirs, penstocks, and restoration of the pre-dam river channel would eliminate areas of wide, deep water crossings that currently represent a hindrance to large and small mammal movements from one side of the river to the other or upland migration for reptiles. Following removal of the reservoirs, relatively narrow and shallow water crossing points would be available for both large and small terrestrial species to move across the river. This would provide long-term benefits to wildlife in the terrestrial resources Primary Area of Analysis by increasing the amount of habitat available to these species, making them less vulnerable to disease, malnutrition, and other environmental stressors as compared with existing conditions.

To facilitate the restoration of reservoir habitat and growth of planted vegetation, permanent cattle exclusion fencing would be installed around the reservoir restoration areas (Appendix B: *Definite Plan - Appendix H*) prior to drawdown or shortly after the pioneer seeding. (It is unknown at this time if this fencing would remain following the transfer of Parcel B lands.) Cattle are currently allowed to free-range graze on the hillsides adjacent to the Lower Klamath Project reservoirs, and the purpose of proposed cattle exclusion fencing would be to prevent cattle from grazing on newly restored vegetation once the reservoirs are drawn down. The fencing would be wildlife-friendly and as such would allow for deer, turtles, and small mammals to move under or over the fencing, while preventing cattle from moving beyond the fencing. As wildlife would be able to safely move under or over the cattle exclusion fencing, there would be no long-term impact due to alteration of wildlife movement corridors.

Significance

Beneficial in the long term due to overall increased wildlife movement opportunities

No significant impact with respect to the use of wildlife-friendly fencing

Potential Impact 3.5-30 Long-term effect on terrestrial wildlife from an increase in the distribution of salmon-derived nutrients upstream of Iron Gate, Copco No. 1 and Copco No. 2 dams.

The Proposed Project would result in changes to the amount and distribution of habitat types and consequently to the species that depend on them, as described in Potential Impact 3.5-25. Removal of the Lower Klamath Project would enable salmon and other fish species to migrate to reaches upstream of Iron Gate Dam, providing nutrient-rich food for terrestrial species, including bald eagles, osprey, and many other species of birds and mammals. These consumers would subsequently deposit these marine-derived nutrients into terrestrial habitats, increasing productivity of riparian vegetation and benefiting the terrestrial ecosystem as a whole (Hilderbrand et al. 2004, Merz and Moyle 2006, Moore et al. 2011). This would be a beneficial effect.

Significance

Beneficial

3.5.6 References

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3.6 Flood Hydrology

This section focuses on potential changes to flood hydrology due to the Proposed Project. Historical and current surface water hydrology in the Klamath Basin are complex; however, only elements of the hydrology related to the Proposed Project's potential to impact floodplain inundation extent and flood risk to people and/or structures are described in this section. The potential for changes in flood hydrology and/or floodplain inundation extent to impact aquatic resources is discussed in Section 3.3; the potential to impact terrestrial resources is discussed in Section 3.5. Other sections of this EIR discuss water quality (Section 3.2), groundwater (Section 3.7), and water supply/water rights (Section 3.8).

Many comments were received during the NOP public scoping process relating to flood hydrology (Appendix A). These comments were primarily concerned with the potential effects of dam and reservoir removal on flood hydrology and impacts to flood inundation areas downstream of the Lower Klamath Project. Examples of specific concerns include the potential for flooding to become more likely and/or flood inundation areas to expand, and concerns about the associated economic impacts, loss of structures, and public safety. See Appendix A for further summary of the flood hydrology comments received during the NOP public scoping process, as well as the individual comments themselves.

3.6.1 Area of Analysis

The Area of Analysis for flood hydrology includes the Klamath River downstream of the California-Oregon border, which lies in portions of three California counties (Siskiyou, Humboldt, and Del Norte). Hydrologic characteristics of features in the Upper Klamath Basin in Oregon are discussed in this section as they pertain to potential impacts to stream flow inputs into California.

The downstream outlet of Upper Klamath Lake in Oregon is the Link River Dam which releases water into the Link River. About one mile below the Link River Dam, the Link River flows into Keno Reservoir/Lake Ewauna. The Keno Reservoir/Lake Ewauna is controlled by the Keno Dam near Keno, Oregon. The Klamath River begins at the historical outfall of Lake Ewauna, which is upstream of Keno Dam. Water impounded by Keno Dam floods the historical Lake Ewauna outfall. The Klamath River flows approximately 250 miles from the historical outfall of Lake Ewauna, through Keno Dam, through the Lower Klamath Project, and to the Pacific Ocean near Klamath, California (see Figure 3.6-1).

The Upper Klamath Basin upstream of Iron Gate Dam includes Upper Klamath Lake and its tributaries, Link River, the Keno Reservoir/Lake Ewauna, and the Hydroelectric Reach (from J.C. Boyle Dam to Iron Gate Dam). Facilities that are part of the Klamath Hydroelectric Project and USBR's Klamath Irrigation Project control surface water distribution in the Upper Klamath Basin via diversions from the Upper Klamath River (FERC 2007) (see also Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*). The Mid Klamath Basin includes the areas of the Klamath Basin from Iron Gate Dam downstream to the Trinity River confluence. Tributaries to the Mid Klamath Basin include the Shasta, Scott, and Salmon Rivers. The Lower Klamath Basin extends from the Trinity River confluence to the Pacific Ocean and includes the Klamath River Estuary and mouth, which are on the northern California coast approximately 50 miles south of the Oregon border.

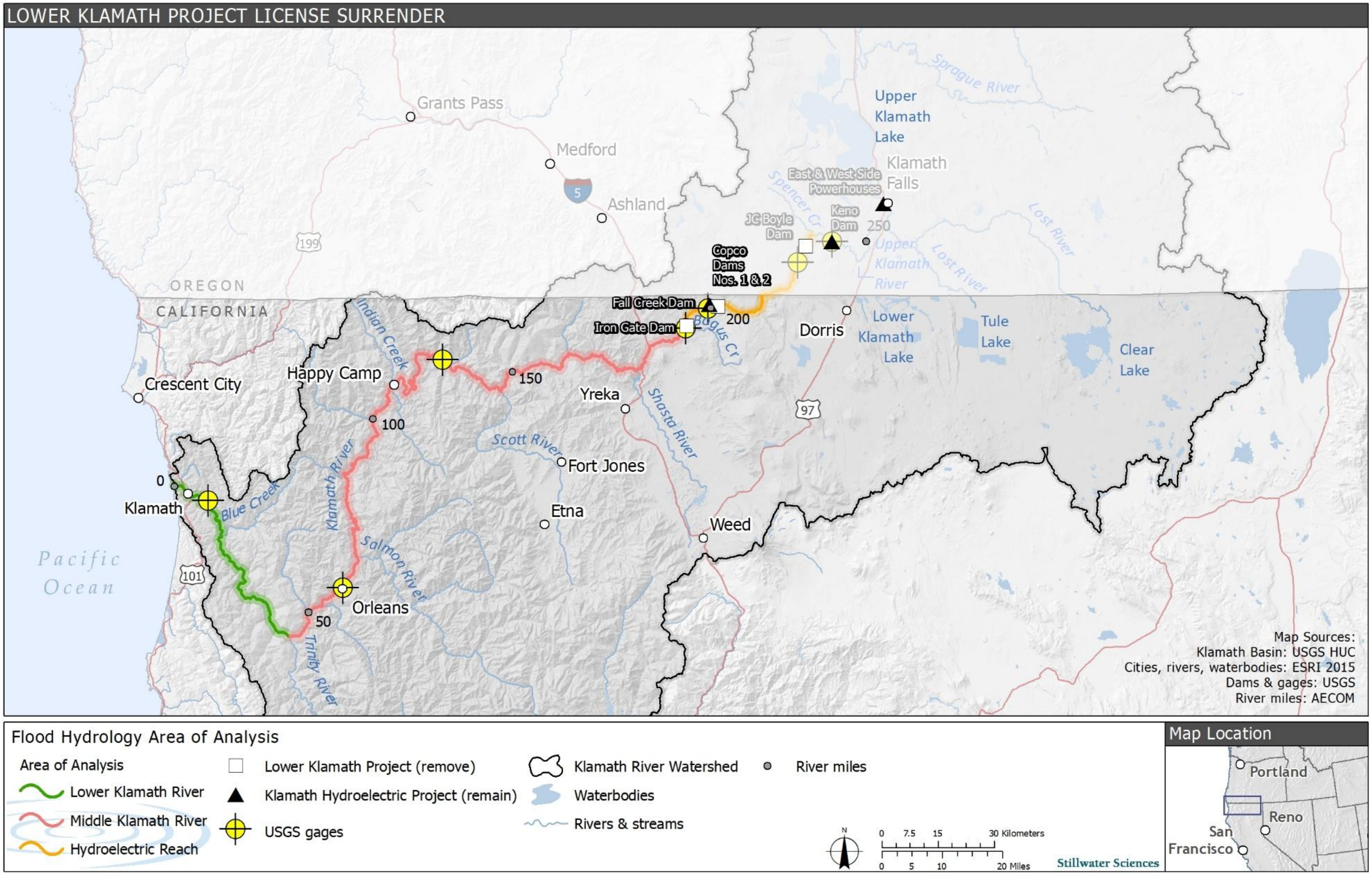

Figure 3.6-1. Flood Hydrology Area of Analysis.

3.6.2 Environmental Setting

This section describes the hydrologic conditions of surface waters in the Klamath Basin. Figure 3.6-1 shows the Area of Analysis. This section includes a description of basin hydrology including precipitation; reservoirs; major rivers and tributaries; lakes; springs and seeps providing measurable flow; historical stream flows; and flood hydrology. Existing average daily and monthly river flows and their relationship to USBR's Klamath Irrigation Project and PacifiCorp's Klamath Hydroelectric Project are also described throughout this section.

3.6.2.1 Historical Hydrologic Conditions

Pre-Dams and Pre-Klamath Irrigation Project Hydrology

Several studies have been conducted to determine the natural flow conditions of the Klamath Basin (USBR 2005); however, these studies are limited by a lack of flow data. Prior to development of dams and implementation of USBR's Klamath Irrigation Project, the Upper Klamath Basin contained lakes and large areas of marshes and wetlands. Upper Klamath Lake was not much larger than its current size; however, Tule Lake and Lower Klamath Lake were much larger. Tule Lake was approximately 7 times larger and Lower Klamath Lake was as much as 35 times larger (Dicken and Dicken 1985). Springs, snowmelt, and groundwater-dominated rivers carrying water from the Cascades and other highlands in the Upper Basin contributed greatly to Upper Klamath Lake, the Klamath River, and the wetlands and marshes in that area (Akins 1970). The elevation of Upper Klamath Lake was originally bedrock-controlled at its outlet. Water then flowed 1.3 miles down the Link River to Lake Ewauna. Lake Ewauna developed because of another natural bedrock control point near Keno, Oregon. Before construction of dams and other water control structures, the Klamath River began at the outfall of this bedrock control forming Lake Ewauna.

During high flow events out of Upper Klamath Lake, some water would flow down the Lost River Slough and into Tule Lake, another natural sump and wetland area. Water that flowed into the Klamath River reached another split near Keno (Akins 1970).

During flood conditions, water would also back up from the Keno bedrock control point and flow into the Klamath Straits and down to Lower Klamath Lake. The Lower Klamath Lake and Tule Lake areas once contained large areas of wetlands and marshes. The Lost River flowed from Clear Lake to Tule Lake. A diversion currently provides water from the Lost River to the Klamath River (Akins 1970).

The presence of both historical Tule and Lower Klamath lakes influenced flows in the Klamath River. Lower Klamath Lake (approximately 47 square miles of open water and 86 square miles of marsh) was connected to the Klamath River through the Klamath Straits. The historical Tule and Lower Klamath lakes saw increased flood inundation and lake surface area during spring snowmelt and subsequent draining of the inundated areas during the late summer and fall. Lower Klamath Lake provided some short-term storage by reducing the total volume of water leaving the upper watershed as well as delaying the peak flow. Tule Lake received overflow during high flow periods from the Klamath River near Klamath Falls, Oregon. Tule Lake was a terminal lake system; the overflow through the Lost River Slough reduced peak flows in the Klamath River in late winter and spring (Abney 1964).

Historical Land Uses Affecting River Flows

Prior to the discovery of gold in California in 1848, which prompted a dramatic influx of European immigrants to California and the Klamath Basin, the region had been inhabited for millennia by native peoples belonging to the Klamath Tribes, Shasta, Karuk, Hoopa, and Yurok. Euro-American settlement in the Klamath River watershed continued throughout the 19th Century. Sustained logging enterprises appeared in the 1880's, and the first hydroelectric development in the Klamath Basin was established in 1891 in the Shasta River Canyon below Yreka Creek.

Additional hydrologic changes to the mainstem of the Klamath Basin were triggered by the passage of the Reclamation Act of 1902 (Reclamation Act) by the U.S. Congress and the subsequent authorization of USBR's Klamath Irrigation Project in 1905. The Reclamation Act supported development in the "arid West" by allowing the Federal Government to fund irrigation projects (USBR 2010). In 1905, the Oregon and California legislatures and the U.S. Congress passed the Cession Act for all necessary legislation to begin USBR's Klamath Irrigation Project (USBR 2011). Afterwards, USBR began building the Klamath Irrigation Project, which led to the construction of the Link River Dam, hundreds of miles of irrigation ditches and large canals and pumping plants to divert water from the Klamath River watershed for agricultural use (FERC 2007). This infrastructure supported the agricultural community which was already well established in the Upper Klamath Basin and allowed for reclamation of additional wetlands for agricultural use (FERC 2007).

Development of hydroelectric plants in the Klamath Basin began as early as 1891 in the Shasta River Canyon to provide electricity for the City of Yreka. In 1895, another facility was constructed on the east side of the Link River to supply power to Klamath Falls, Oregon. Additional power suppliers developed facilities in the area on Fall Creek and the West Side plant on the Link River (FERC 2007).

3.6.2.2 Basin Hydrology

This section begins with an historical description of changes to Klamath River hydrology that have occurred associated with development of water management features in the past century and longer. The section then summarizes basin precipitation and stream flows before describing reservoirs, rivers, and creeks in the affected environment. Various springs and seeps occur in the vicinity of Iron Gate, Copco No. 1, Copco No.2, and J.C. Boyle dams and contribute flows to surface waters. Springs around Upper Klamath Lake provide inflow to many of the streams feeding the lake and also provide stability for area wetlands (Akins 1970). Section 3.7.2.1 *Regional Groundwater Conditions* describes the locations of springs and seeps in more detail. Some measurable inflows from springs and seeps to various surface waters are described below. Figure 3.6-1 shows the major rivers, dams, and reservoirs in the Klamath Basin, as well as USGS gaging locations.

Historical Water Management Changes to Klamath River Hydrology

The following provides a brief description of changes to Klamath River hydrology that have occurred through development of water management features related to irrigation, power generation, and environmental requirements over the past century and longer. The major hydrologic time periods discussed include a description of: 1) natural hydrology prior to development of major reclamation or hydroelectric facilities (pre-1903; 2) major hydrologic alterations caused by development of power peaking facilities (1903 to 1962); and 3) hydrology following construction of Iron Gate Dam in 1962 through 2000, when ESA flow requirements began to influence water releases downstream from Iron Gate (for more detail see Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*).

Owing to the long history and early development of water resources within the basin, little hydrologic data exist to describe the natural flow patterns that existed prior to construction of USBR's Klamath Irrigation Project. The first streamflow records on the Klamath River began on June 1, 1904, when the USGS began operating a flow gage on the Klamath River at Keno (USGS Gage No.11509500). River flow data for the USGS gage at Keno are available for water years 1905 through 1912, after which the gage was discontinued until 1930. The Lost River Diversion Dam was completed in 1912, which affects Klamath River hydrology (Hecht and Kamman 1996). Therefore, flow data collected at Keno from 1905 through 1912 provide the best record of unaltered hydrologic conditions prior to construction of major irrigation facilities in the upper basin. Although the 1905 through 1912 period is known to be slightly wetter than normal, the general flow conditions are still useful for understanding the general timing, magnitude, and duration of flow throughout the year under near natural conditions. Over this eight-year period the total annual discharge at Keno ranged from a low of 1,345,000 acre-feet to a high of 1,952,000 acre-feet and averaged about 1,558,000 acre-feet. Examination of three different water years, representing conditions that range from dry to wet, provide a sense of the natural flow variation that existed under natural conditions (Figure 3.6-2). Average daily flows for the 1905–1912 water years therefore provide the most reasonable set of data to assess hydrologic changes in the Klamath Basin through time as various irrigation and hydropower generation facilities were constructed. For the purposes of the following discussion, the term "natural" applies to the period prior to construction of either the hydroelectric or irrigation systems in the Klamath Basin, with river flows best represented by the 1905–1912 data.

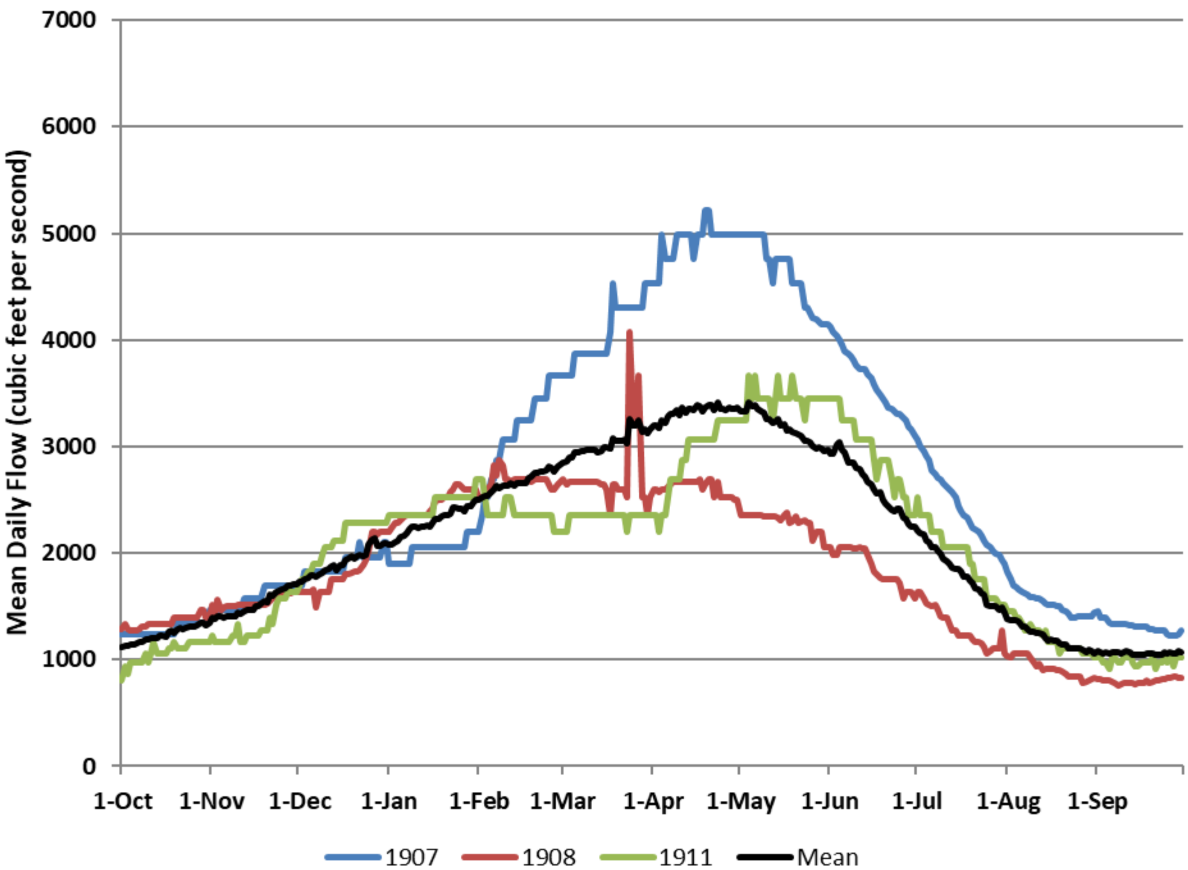

Figure 3.6-2. Mean Daily Flows (cubic feet per second) for the Klamath River at the USGS Gage at Keno for three Different Water Years, Generally Representing Drier (1908), More Normal (1911), and Wetter (1907) Conditions. Mean daily flows for water years 1905 through 1912 are also displayed to illustrate the natural flow regime that existed prior to development of major reclamation or hydroelectric projects.

Although there are no empirical river discharge data downstream from Keno prior to implementation of USBR's Klamath Irrigation Project, modeling results of flows near Iron Gate Dam without USBR's Klamath Irrigation Project show similar patterns to the natural discharge downstream of Keno (USBR 2005). Spring peaks from snowmelt in tributary basins reliably provided an increase in discharge, typically near the end of April (NRC 2004), with base flows subsequently declining to a minimum in the beginning of September.

As described below in the Keno Reservoir/Lake Ewauna section, bedrock originally controlled the elevation of Upper Klamath Lake and river flows downstream to the Link River. The Link River is only 1.3 miles long and ends at the upper extent of Lake Ewauna and the Keno Reservoir. Though a range is not identified, historical accounts describe the occurrence of extremely low flows in Link River during prolonged dry spells. These extremely low flow conditions were most likely caused by strong south winds (i.e., blowing upstream) forming seiches[135] (within Upper Klamath Lake which greatly diminished flows to the Link River for brief periods of time (Dicken and Dicken 1985). Inputs from tributary streams and natural springs downstream from Keno would have maintained flow in the Klamath River and prevented it from drying completely farther downstream near the current location of Iron Gate Dam.

In the Lower and Mid Klamath basins, the hydrologic pattern of the Klamath River was primarily dominated by rainfall events in the fall, winter and spring. In the middle and lower portions of the Klamath River, discharge responds rapidly to rainfall due to the relatively short length of lower tributary sub-basins (e.g., Salmon River). The natural Klamath River hydrology was diverse, with a range of hydraulic conditions affected by both the Upper Klamath Basin patterns previously described (e.g., Figure 3.6-2) and lower basin tributary inputs (see *Precipitation and Stream Flows* subsection, below).

Copco No. 1 and Copco No. 2 facilities were constructed to generate hydroelectric power and their operation greatly altered flow patterns downstream. The USGS gage on the Klamath River near Fall Creek, downstream from Copco No. 1 and Copco No. 2 dams, began recording flows at this location in October 1923 (USGS Gage No. 11512500). Flow data are available from USGS Gage No. 11512500 until 1962 when construction of Iron Gate Dam inundated the river at this location. Hydroelectric power peaking operations at Copco No. 1 and Copco No. 2 caused major changes to the hydrograph downstream from the Copco No. 2 powerhouse (Figure 3.6-3). Rapid changes in flow associated with hydropower generation, commonly referred to as power peaking, created both hazardous conditions for recreational fishermen and inhospitable conditions for aquatic species downstream. Mean daily flows fell below 100 cfs at USGS Gage No. 11512500 on 50 occasions between water years 1931 and 1937. Thus, hydropower peaking between 1918 and the construction of Iron Gate Dam to re-regulate flows in 1962 may explain some anecdotal accounts of the occurrence of low flows in the Klamath River in the past that were submitted by citizens during public scoping of the 2012 KHSA EIS/EIR (USBR and CDFG 2012) and the Lower Klamath Project EIR (see Appendix A).

Iron Gate Dam was completed in 1962 to re-regulate peaking flow releases from the Copco facilities upstream. At that time minimum flow releases downstream were stipulated by FERC under Article 52 of the FERC License for operation of Project No. 2082. Article 52 required the following minimum flows downstream from Iron Gate Dam: 1,300 cfs from September 1 through April 30; 1,000 cfs from May 1 through May 31; 710 cfs from June 1 through July 31; and 1,000 cfs from August 1 through August 31. These flow requirements provided more stable flow conditions downstream; however, they also altered the timing of base flows and did not attempt to restore or simulate the natural hydrograph. Fall flows were slightly increased while spring and summer flows were substantially reduced compared to natural flows. Figure 3.6-4 illustrates this alteration.

[135] A seiche is a standing wave oscillating in an enclosed, or partially enclosed, body of water (NOAA 2018). Seiches are typically caused when atmospheric (i.e., wind or pressure) or seismic forces push water from one end of the body of water to the other. Eventually, the water rebounds to the other side of the body of water and then continues to oscillate back and forth for hours or even days.

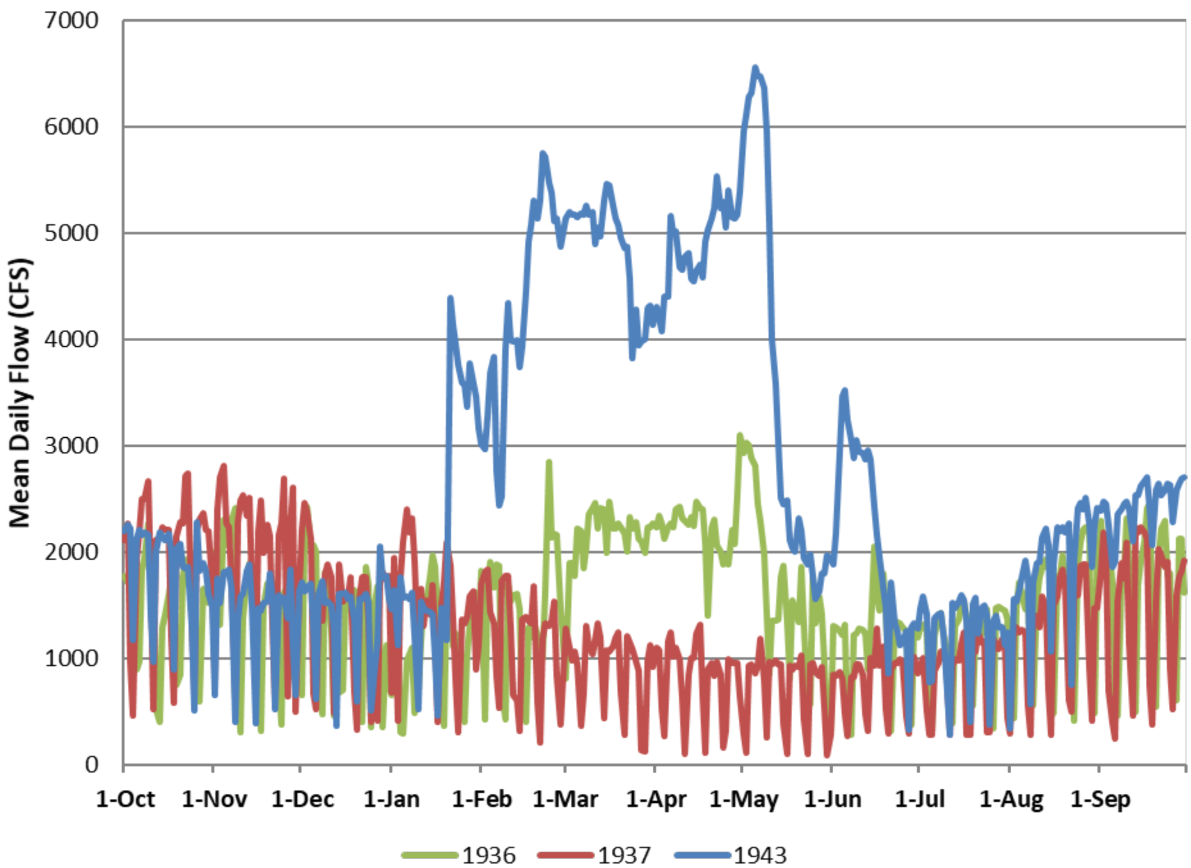

Figure 3.6-3. Mean Daily Flows (cubic feet per second) for the Klamath River at the USGS Gage Near Fall Creek (Gage No. 11512500) for Three Different Water Years, Generally Representing Drier (1937), Normal (1936), and Wetter (1943) Conditions.

Hecht and Kamman (1996) analyzed the hydrologic records for similar water years (pre- and post-Project) at several locations along the Klamath River. The authors concluded that the timing of peak and base flows changed significantly after construction of USBR's Klamath Irrigation Project (KIP), and that the operation of the KIP increases flows in October and November and decreases flows in the late spring and summer as measured at Keno, Seiad, and Klamath USGS gage sites. Comparison of mean daily flows recorded at Keno (USGS Gage No. 11509500) from 1905 to 1912 with mean daily flows recorded at Keno and Iron Gate (USGS Gage No. 11516430) in more recent years (1961–2000) illustrate these findings (Figure 3.6-4).

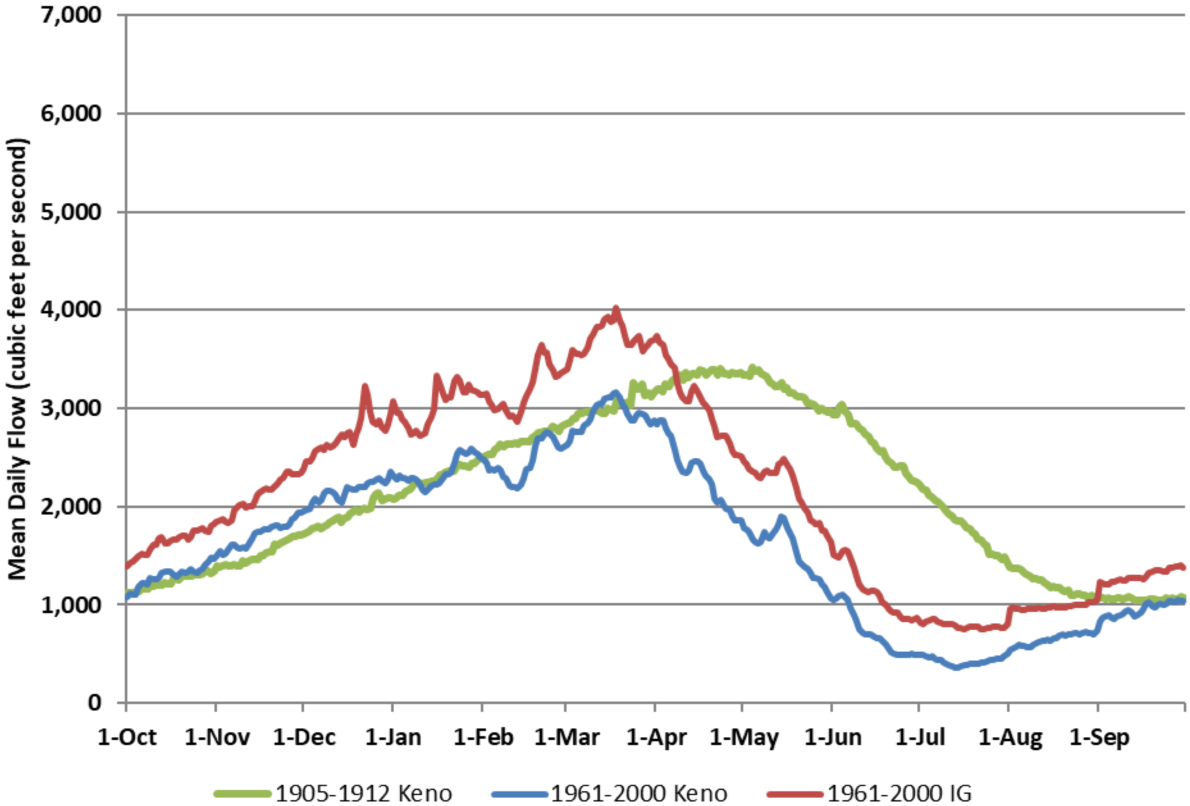

Figure 3.6-4. Comparison of Mean Daily Flows Recorded at Keno (USGS Gage No. 11509500) Historically (1905–1912) with More Recent Conditions (1961–2000). Mean daily flows recorded at Iron Gate (USGS Gage No. 11516530) are shown to depict both the mean daily accretions and similarities that exist in the hydrograph between Keno and Iron Gate.

During the period from 1961 through 2000, the timing and magnitude of average flows in the Klamath River at Keno changed relative to the natural flow regime (Figure 3.6-4). USBR's Klamath Irrigation Project water diversions from the Klamath River in the spring and summer significantly reduced flow volumes in the Klamath River from approximately April until September. The extraction of water significantly accelerated the decline of flow rates during the spring runoff and had the effect of moving the spring runoff peak from the end of April and beginning of May to the middle of March, a shift of more than one month. Although most of the diverted water remained within the basin, a combined total of about 30,400 acre-feet of water was diverted annually from Jenny Creek (tributary to the Klamath River at Iron Gate Reservoir) and Fourmile Lake (tributary to Upper Klamath Lake) to the Rogue River Valley for irrigation and hydropower production. Under natural conditions, river discharge did not reach base (minimum) flow, until September. Operation of USBR's Klamath Irrigation Project caused a shift in the onset of minimum base flow levels by about two months earlier in the summer from September to July. Tributary inflows and spring flow accretions, the most prominent being Big Springs (about 250 cfs) in the J.C. Boyle Bypass Reach, accounts for the difference in mean daily flow between Keno and Iron Gate.

Minimum flow requirements, based on consideration of ESA species, at Iron Gate Dam have gone through multiple iterations (e.g., 2002 Biological Opinion, 2008 Biological Opinion, KBRA/2010 Biological Opinion) and are currently operated under the 2013 Joint Biological Opinion (BiOp) and court-ordered flushing flows (for more detail see Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project,* and the *Iron Gate Reservoir* subsection below) (NMFS and USFWS 2012, U.S. District Court 2017).

Precipitation and Stream Flows

The Upper Klamath Basin receives rain at all elevations and snow at elevations above 4,000 feet (above mean sea level [amsl]) during the late fall, winter, and spring. Snow is the primary form of precipitation in the upper watershed. Depending on the elevation and location, the amount of precipitation ranges from approximately 10 to more than 50 inches per year. From 1907 through 1997 the average annual precipitation at Klamath Falls was 13.4 inches and from 1959 to 2009 it was 20 inches at Copco No. 1 Dam (USBR 2010). Peak stream flows generally occur during snowmelt runoff from March through May. After the runoff has stopped, flows drop to low levels in the late summer or early fall. Fall storms may increase flows compared with the lower summer flows. Generally, conditions in the Upper Klamath Lake area are drier than the area where the Klamath River reaches the ocean (Figure 3.6-5). The reaches downstream from the confluence of the Klamath and Shasta rivers receive higher levels of precipitation than other reaches in the Klamath Basin (FERC 2007). Average annual precipitation is 49 inches at Happy Camp from 1914 to 2010 and 80 inches at Klamath between 1948 and 2006 (Desert Research Institute 2011).

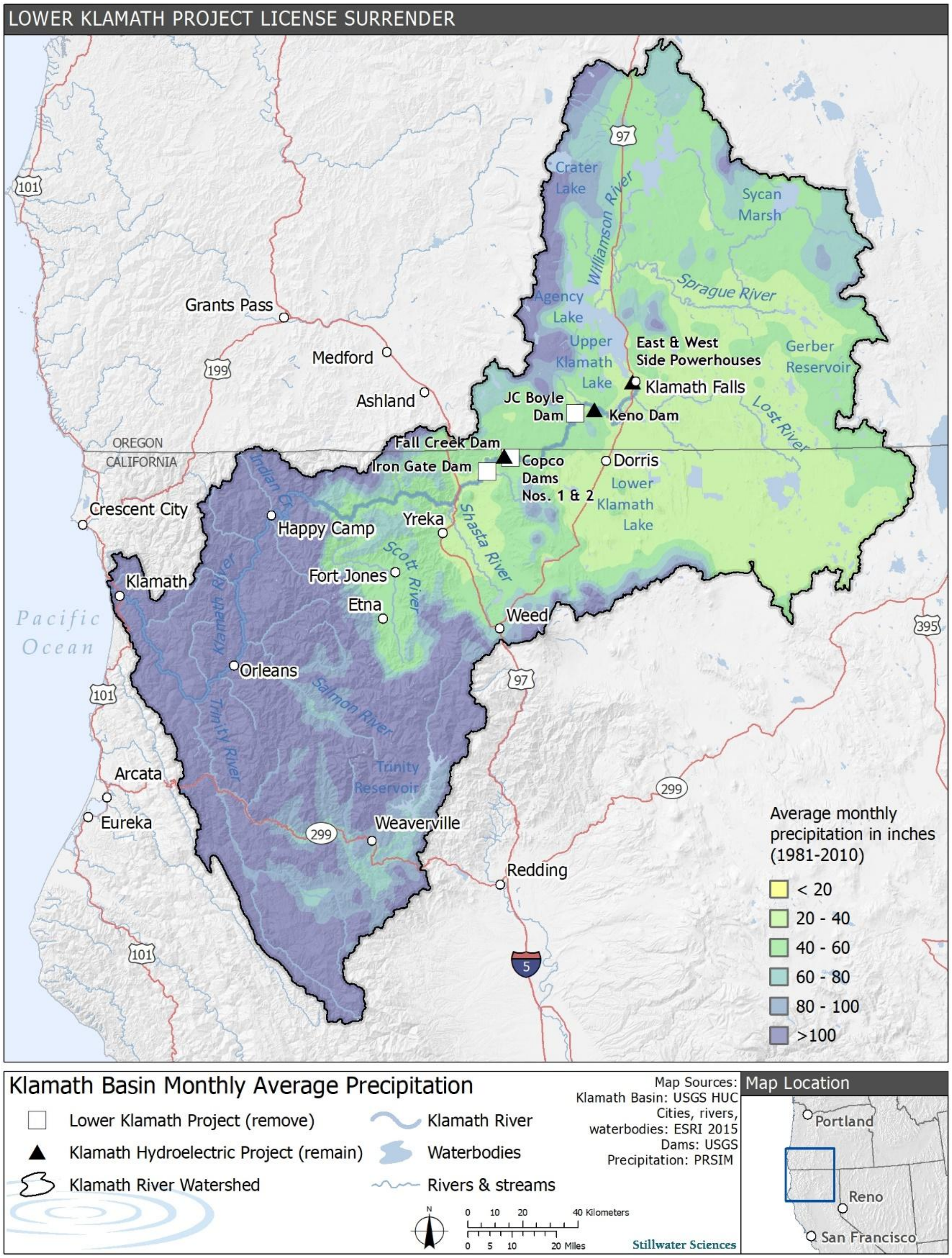

Figure 3.6-5. Mean monthly precipitation across the Klamath River watershed (1981–2010).

The following graphs and tables provide more detail regarding precipitation and streamflow from the upper to the lower watershed, as well as information on the range of hydrologic conditions. The USGS stream gages on the Klamath River are summarized in Table 3.6-1 and Figure 3.6-1. Summer and early fall periods (July through October) generally have much lower flows than during spring runoff. Tributaries downstream from Iron Gate Dam contribute substantial amounts of flow. Figure 3.6-6 shows historical daily average stream flows at several locations on the river using USGS monitoring data from 1961 to 2009 (USGS 2011). Flows are substantially higher during wet years; Table 3.6-2 shows historical average monthly flows during wetter years (represented by flows exceeded 10 percent of the time) using the same USGS data (USGS 2011). Table 3.6-3 shows the daily average flows at the four primary hydroelectric dams. The column indicating “Percent of time equaled or exceeded” indicates the hydrologic conditions, with 99 percent being extremely dry conditions and 1 percent being extremely wet conditions.

Table 3.6-1. USGS Gages on the Klamath River.

USGS Gaging Station	Station Name	Drainage Area (miles^2)	Latitude	Longitude	Gage Elevation (feet amsl)	Period of Record (Water Years)
11509500	Klamath River at Keno, OR	3,920	42°08’00”	121°57’40”	3,961	1905–1913 1930–2016
11510700	Klamath River below J.C. Boyle Power Plant near Keno, OR	4,080	42°05’05”	122°04’20”	3,275	1959–2016
11512500	Klamath River below Fall Creek near Copco, CA	4,370	41°58’20”	122°22’05”	2,310	1924–1961
11516530	Klamath River below Iron Gate Dam, CA	4,630	41°55’41”	122°26’35”	2,162	1961–2016
11520500	Klamath River near Seiad Valley, CA	6,940	41°51’14”	123°13’52”	1,320	1913–1925 1952–2016
11523000	Klamath River at Orleans, CA	8,475	41°18’13”	123°32’00”	356	1927–2016
11530500	Klamath River near Klamath, CA	12,100	41°30’40”	123°58’42”	5.6	1911–1927 1932–1994, 1996, 1998–2016

Source: USBR 2012.

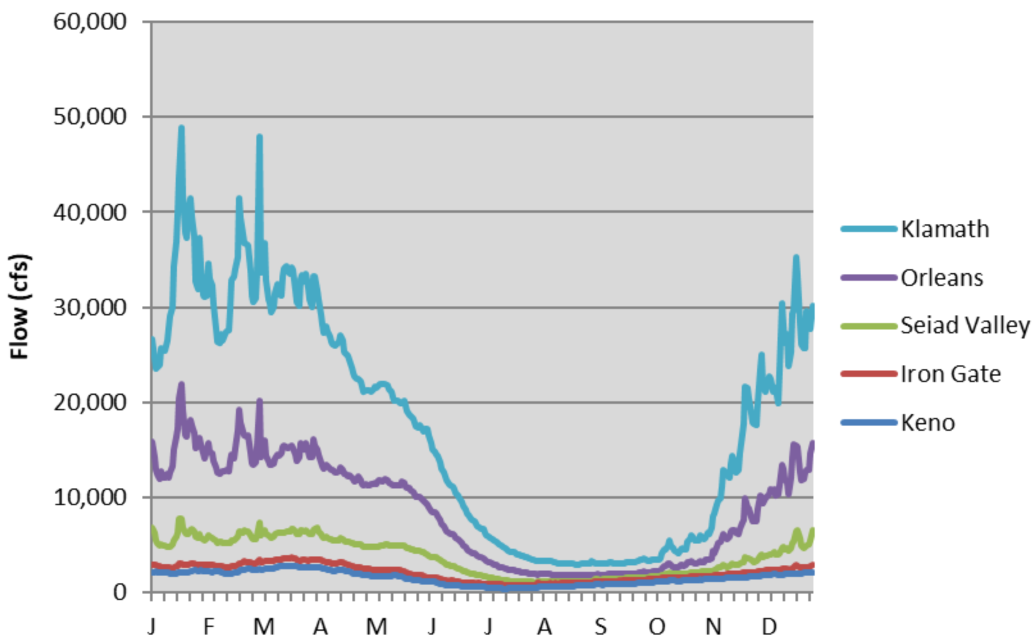

Figure 3.6-6. Daily Average Flows at Five USGS Stream Gages on the Klamath River. Source: USGS 2011.

Table 3.6-2. Historical Monthly Average Flows (cfs) in Wetter Years (10 Percent Exceedance Level) during Water Years 1961–2009 on the Klamath River.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Keno Dam	2,053	2,625	3,304	3,645	4,703	5,691	4,543	3,046	1,525	755	788	1,225
J.C. Boyle Dam	2,271	2,824	3,449	3,720	4,727	5,741	4,766	3,346	1,823	1,010	1,035	1,441
Iron Gate Dam	2,447	3,047	3,994	4,544	5,567	6,429	5,487	3,918	2,003	1,059	1,094	1,582
Seiad Valley	3,070	4,606	9,372	11,866	11,129	11,658	9,516	8,077	5,262	1,985	1,461	1,903
Orleans	4,031	11,635	28,185	33,198	23,710	25,697	2,0345	18,408	11,277	4,060	2,343	2,418

Source: USGS 2011

Table 3.6-3. Annual and Seasonal Daily Flows.

Percent of Time Equaled or Exceeded	Discharge (cfs)							
	Annual				Seasonal (July 1–Nov 31)			
	Keno	Boyle	Copco	Iron Gate	Keno	Boyle	Copco	Iron Gate
99	152	331	290	528	147	325	294	441
95	297	522	529	716	292	473	524	701
90	431	635	643	741	417	592	604	725
80	645	802	882	955	621	725	823	846
70	821	962	1,088	1,040	737	856	973	1,000
60	990	1,130	1,269	1,320	901	960	1,150	1,030
50	1,180	1,260	1,483	1,360	1,020	1,060	1,273	1,130
40	1,440	1,480	1,730	1,700	1,180	1,180	1,470	1,320
30	1,800	1,810	2,104	1,977	1,390	1,280	1,670	1,350
20	2,390	2,660	2,640	2,980	1,580	1,490	1,905	1,510
10	3,120	3,200	3,350	3,870	1,960	1,890	2,300	1,840
5	4,320	4,530	4,486	5,500	2,450	2,710	2,720	2,920
1	6,875	7,660	7,295	9,167	3,300	3,970	3,536	4,350

Source: USBR 2012

Upper Klamath Basin

Upper Klamath Lake and Link River Dam

Link River Dam was constructed in 1921 at the natural outlet of Upper Klamath Lake by California Oregon Power Company (now PacifiCorp). The dam, deeded to the United States, is operated and maintained by PacifiCorp under the direction of USBR. Upper Klamath Lake has active total storage capacity of approximately 629,780 acre-feet including areas restored by levee and dike breaches at Tulana Farms and Goose Bay and pumped storage at Agency Lake and Barnes Ranches (Table 3.6-4) (FERC 2007). Currently, USBR manages Upper Klamath Lake for irrigation delivery and in accordance with USFWS and NOAA Fisheries Service biological opinions regarding lake levels and downstream flows, based on current and expected hydrologic conditions (USBR 2010).

Table 3.6-4. Klamath River Reservoir Information.

Reservoir	Surface Area (acres)	Average Yearly Inflow [a] (cfs)	Average Depth [a] (feet amsl)	Maximum Depth [a] (feet amsl)	Active Storage (acre-feet)	Total Storage (acre-feet)	Retention Time (days)
Upper Klamath Lake	67,000[a]	1,450	9	60	486,830[a, b]	629,780[a, b]	219[a]
Keno	2,475[a]	1,575	7.5	20	495[a, b]	18,500[a, b]	5.9[a]
J.C. Boyle	350[c]	1,575	8.3	40	1,724[a, b]	2,267[c]	1.1[a]
Copco No. 1	972[c]	1,585	47	108	6,235[a, d]	33,724 [c]	10.7[a]
Copco No. 2	N/A[c]	1,585	[e]	[e]	0[a, b]	70[c]	0[a]
Iron Gate	942[c]	1,733	62	167	3,790[a, d]	50,941 [c]	14.8[a]

Notes:
[a] Source: FERC (2007).
[b] Storage volumes are from Table A2.1-1 of PacifiCorp's Exhibit A, as cited in FERC (2007).
[c] Source: AECOM et al. (2017). Data have been adjusted from those reported in FERC 2007 and USBR 2012a based on available data (e.g., as-built drawings, aerial photographs, topographic information).
[d] Storage for Copco No. 1 Reservoir between the normal maximum water level and the invert of the penstock intakes is approximately 20,000 acre-feet. Storage for Iron Gate Reservoir between the normal maximum water level and invert of the penstock intake is approximately 24,000 acre-feet, as reported in FERC (2007).
[e] Very small reservoir, no information on depth provided.

Outlets from Upper Klamath Lake include the Reclamation A Canal, PacifiCorp's East Side and West Side development canals and the Link River Dam. Water that passes through the East Side and West Side development canals re-enters the Link River downstream from the dam where it eventually enters Keno Reservoir/Lake Ewauna (FERC 2007).

USBR's Klamath Irrigation Project (KIP)

Operation of USBR's Klamath Irrigation Project affects Klamath River flows and Upper Klamath Lake water surface elevations. Link River Dam is the primary structure controlling the level of Upper Klamath Lake and releases of water to the Klamath River. Upper Klamath Lake water level fluctuation is approximately four to five feet annually, reaching a maximum (about 4,143 feet amsl, USBR datum) near the beginning of the irrigation season in April, and often dropping below 4,139 feet amsl, USBR datum, at the end of the irrigation season in October. The range of water levels in Upper Klamath Lake depends on many factors, including hydrologic conditions, flood risk management, agricultural demands for irrigation deliveries, and ESA requirements to protect listed fish.

Section 3.8 *Water Supply/Water Rights*, describes the scope of USBR's Klamath Irrigation Project in more detail, including the water supply diversions and amount of water diverted. As a federal agency, USBR is required to comply with the ESA. To meet ESA requirements, USBR operates the Klamath Irrigation Project in compliance with the most recent biological opinion. To comply with ESA, USBR operates the Klamath Irrigation Project to maintain: (1) water surface elevations in UKL for ESA-listed sucker fish; (2) minimum flows in the Klamath River below Iron Gate Dam for threatened Coho salmon. Though Iron Gate Dam is owned and operated by PacifiCorp, PacifiCorp makes releases from Iron Gate Dam for USBR's flow requirements as a result of PacifiCorp's requirements under a habitat conservation plan for coho salmon. Refer to Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* and the *Iron Gate Reservoir* subsection below for additional information on biological opinion flow requirements.

Keno Reservoir/Lake Ewauna and Keno Reach

Lake Ewauna existed before the construction of Keno Dam due to a natural bedrock control point or "reef" as described by others (e.g., Akins 1970). In 1931, Needle Dam was built on the Klamath River near Keno, Oregon and, in 1967, Keno Dam was built to replace Needle Dam. With construction of Keno Dam, the waterbody of Keno Reservoir/Lake Ewauna became a long and narrow lake that begins where the Link River ends, 1.3 miles downstream from the Link River Dam, and ends at Keno Dam. The Keno Dam is owned and operated by PacifiCorp as part of the Klamath Hydroelectric Project. The operations are coordinated with the operations of Link River Dam. Before Keno Dam, the river meandered through swamps for approximately 20 miles. It took two to four days for water released at Link River Dam to reach Copco No. 1 Dam. With the construction of Keno Dam, and dikes along the shores of Keno Reservoir/Lake Ewauna, this travel time has been reduced to 12 hours. The currently normal water surface elevation is 4,085 feet amsl in Keno Reservoir/Lake Ewauna (USGS 2009).

On an annual basis, the majority of the water entering Keno Reservoir/Lake Ewauna comes from Upper Klamath Lake through the Link River. Several notable federal and private facilities upstream of Keno Dam transport water to or from the river including: Lost River Diversion Channel, Klamath Straits Drain, and Ady Canal. The surface elevation of Keno Reservoir/Lake Ewauna is maintained to facilitate the operations of these facilities (FERC 2007).

Historical daily mean discharge for the Klamath River at Keno Dam for the period of record from water years 1961–2015 are shown in Figure 3.6-7.

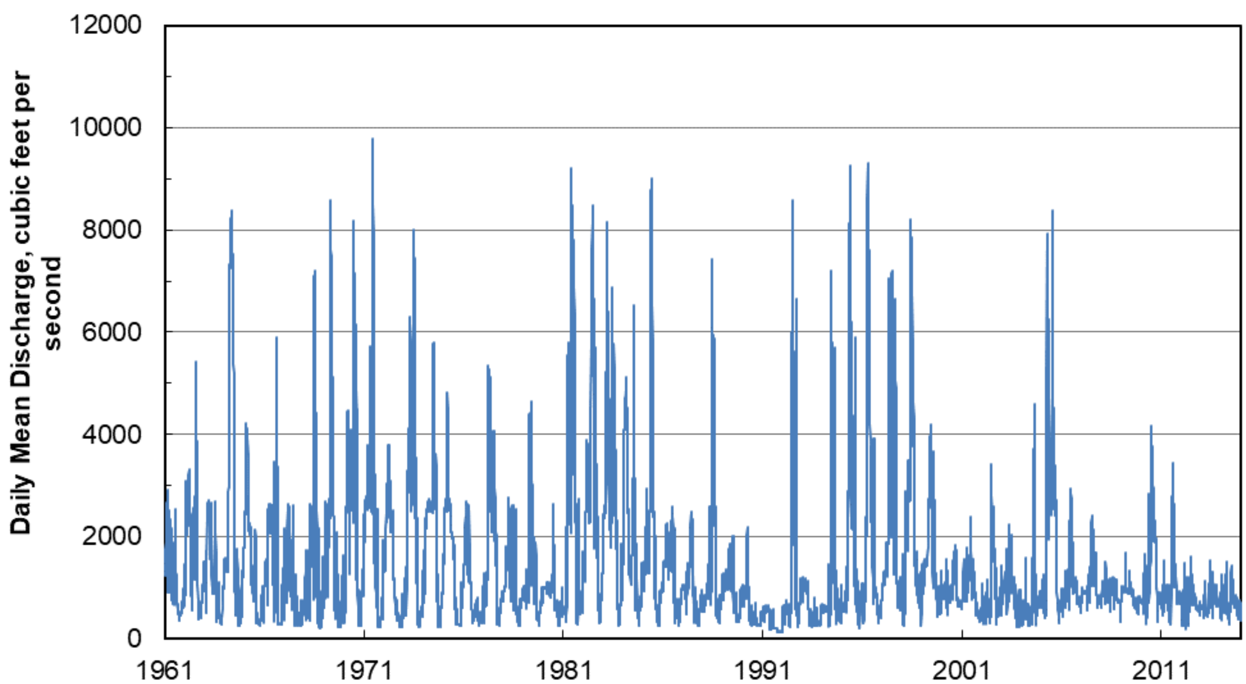

Figure 3.6-7. Discharge for the Klamath River at Keno Dam, 1961–2015. Source: USGS 2016.

J.C. Boyle Reservoir

J.C. Boyle Reservoir is approximately five miles downstream from Keno Dam. PacifiCorp operates J.C. Boyle Reservoir to produce hydroelectric power. Current operations of the reservoir follow Interim Measures from the Interim Conservation Plan effective as of February 2010. Water is spilled from the dam during high flow months of January through May and when inflow exceeds the capacity of the J.C. Boyle powerhouse and low flow requirements (see Table 3.6-5) (FERC 2007).

Table 3.6-5. Average Spillage at J.C. Boyle, Copco No. 1, and Iron Gate Dams from January 2, 1990 through December 5, 2004.

	J.C. Boyle			Copco No. 1			Iron Gate		
	Average # of days	Average[a] (cfs)	Average Monthly Spill [b] (acre-feet)	Average # of days	Average[a] (cfs)	Average Monthly Spill [b] (acre-feet)	Average # of days	Average[a] (cfs)	Average Monthly Spill [b] (acre-feet)
October	1.8	553	2,271	0.0	-	-	1.9	132	552
November	0.0	-	-	0.4	756	772	2.4	523	2,911
December	0.2	1,215	552	1.8	1,783	7,488	5.1	1,395	18,046
January	4.3	2,803	28,235	5.2	3,682	44,378	11.0	1,379	35,539
February	7.1	2,368	37,812	8.4	2,672	50,957	12.1	2,934	79,987
March	7.8	1,738	41,677	7.4	2,774	46,219	17.3	2,297	89,676
April	5.8	1,728	22,750	5.9	2,026	27,205	15.7	1,595	56,608
May	4.7	2,207	21,483	5.3	2,031	24,122	15.0	1,643	66,979
June	1.8	801	3,148	1.1	1,136	2,732	6.1	790	10,930
July	0.1	266	61	0.0	-	-	2.1	56	246
August	0.0	-	-	0.3	96	61	0.2	656	307
September	0.9	456	950	0.0	-	-	0.0	-	-
Yearly	35	2,032	161,272	36	2,506	206,834	89	1,726	352,196

Notes:
Most of water year 1993 is missing for this data set.
[a] Average flow during spill events.
[b] Includes non-spill events
Source: FERC 2007

J.C. Boyle Bypass Reach

The J.C. Boyle Bypass Reach is a moderately steep (approximately 1.7 percent grade), 4.6-mile reach of the Klamath River between the J.C. Boyle Dam and Powerhouse. One-half mile downstream from the dam, flows are increased by groundwater entering the bypass reach. There is currently a 100 cfs minimum required release from J.C. Boyle Reservoir into the J.C. Boyle Bypass Reach (NOAA 2010). The average accretion due to groundwater inflow/spring inflow is an additional 220 to 250 cfs and varies seasonally and from year to year (FERC 2007).

J.C. Boyle Peaking Reach

The J.C. Boyle Peaking Reach is downstream from the J.C. Boyle Powerhouse, so flows vary based on releases from the powerhouse. Typically, the reach has high flows during the day as a result of powerhouse flows used to provide peak energy demand. The powerhouse flows may be reduced to zero at night when J.C. Boyle Reservoir is refilled. The powerhouse ramps up flow for either a one-unit operation (up to 1,500 cfs) or a two-unit operation (up to 3,000 cfs). Normal daily average flows in the peaking reach during periods with no power generation range from 320 to 350 cfs, which includes 80 cfs from the fish ladder and 20 cfs from the juvenile fish bypass system. Additional water enters the reach from springs. Figure 3.6-8 shows historical flows for the Klamath River below J.C. Boyle Powerhouse (USGS Gage No. 11510700) for the period of record from January 1, 1959, through the end of water year 2015. This gage is located at RM 224.5, about 0.7 mile downstream from the powerhouse.

Commercial whitewater rafting and boating occurs during the same months as peak power demands, May through October (see also Section 3.20 *Recreation*). Under PacifiCorp's current annual FERC license, upramping and downramping flows occur at a rate of 9 inches per hour (FERC 2007).

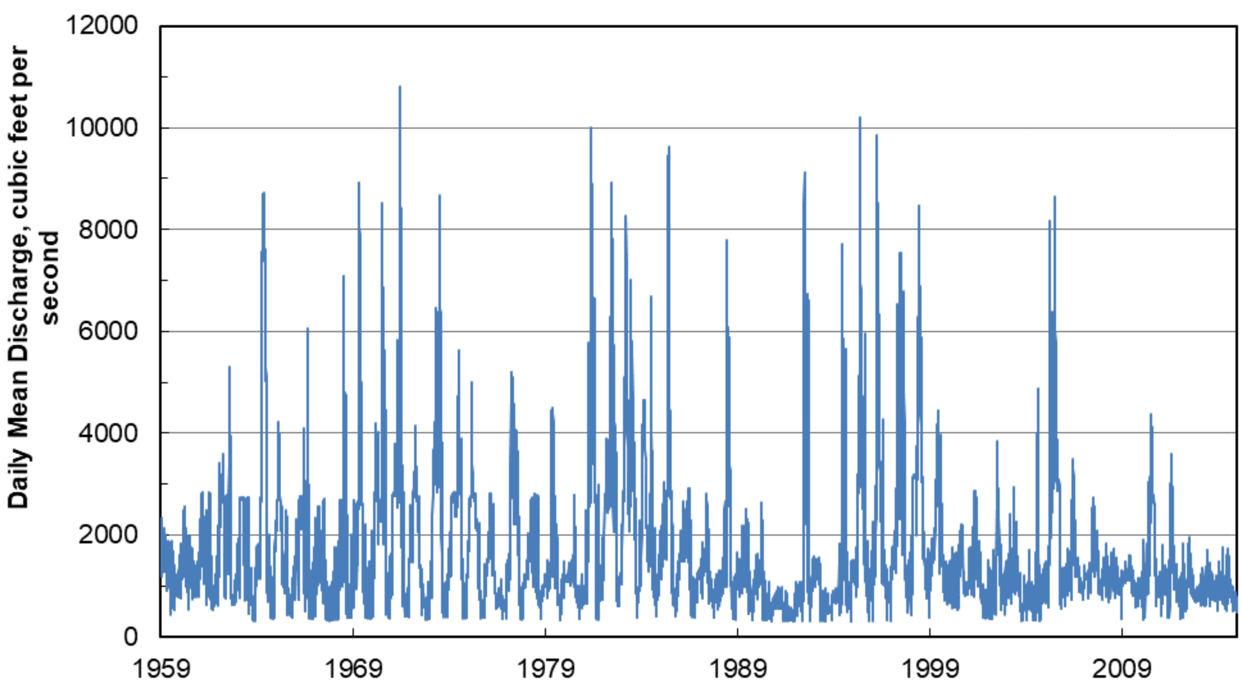

Figure 3.6-8. Discharge for Klamath River Downstream from J.C. Boyle Powerhouse, 1959–2015. Source: USGS 2016.

Copco No. 1 Reservoir

PacifiCorp operates Copco No. 1 Reservoir for hydroelectric power generation through Copco No. 1 Dam. With the most active storage volume of all the Lower Klamath Project reservoirs (6,235 acre-feet for power production), Copco No. 1 Reservoir has a total storage capacity of 46,867 acre-feet (USBR 2012). This reservoir is deeper than both Keno Reservoir/Lake Ewauna and J.C. Boyle Reservoir (FERC 2007).

Copco No. 2 Reservoir and Bypass Reach

Copco No. 2 Reservoir, a small impoundment, receives discharges from Copco No. 1 Reservoir through Copco No. 1 Dam and provides flow to Copco No. 2 Powerhouse through a 1.5-mile conveyance of tunnels and penstocks. The maximum hydraulic capacity is 3,650 cfs, which is the capacity of flow from Copco No. 1 Powerhouse to Copco No. 2 Reservoir. Copco No. 2 Dam controls the flow from the reservoir, and only spills when inflow to the reservoir exceeds storage capacity. Spillage from the dam is rare and typically only happens from November through April. PacifiCorp releases between five to 10 cfs at the bypass reach below Copco No. 2 Dam under normal conditions. Copco No. 2 Powerhouse discharges water to Iron Gate Reservoir (FERC 2007).

Spring, Fall, and Jenny Creeks

Two perennial tributaries, Jenny and Fall creeks, enter Iron Gate Reservoir. Spring Creek is a tributary to Jenny Creek, which flows for 1.2 miles from its source at Shoat Springs before it enters Jenny Creek at RM 5.5. Flow in Jenny Creek is altered by upstream reservoirs that store water during the high runoff season for irrigation as part of the Rogue River Irrigation Project. Approximately 24,200 acre-feet, which is approximately 30 percent of the annual mean runoff of the Jenny Creek watershed, is diverted north into the Rogue River Basin. PacifiCorp estimates that normally between 30 and 500 cfs enters Iron Gate Reservoir from Jenny Creek.

PacifiCorp operates a small diversion dam on Spring Creek that diverts up to 16.5 cfs into Fall Creek, and another dam on Fall Creek that diverts flow into a canal and penstock system leading to the Fall Creek Powerhouse. PacifiCorp states that the Spring Creek diversion was unusable for most of the 1990's, and until 2003, due to a water rights lawsuit with a local landowner, but that the lawsuit was decided in favor of PacifiCorp in 2003. The Spring Creek diversion is located a half mile upstream of its confluence with Jenny Creek, and diverted flow is carried through a 1.3-mile-long canal where it enters Fall Creek, about 1.7 miles upstream of the Fall Creek diversion. PacifiCorp estimates the minimum observed flow in Spring Creek is five cfs. The diversion dam on Fall Creek diverts up to 50 cfs of flow that bypasses 1.5 miles of a steep gradient section (approximately 9 percent) of Fall Creek, leading to the Fall Creek Powerhouse. PacifiCorp's current license requires minimum flows of 0.5 cfs below the Fall Creek diversion and 15 cfs (or natural stream flow, whichever is less) downstream of the powerhouse.

USGS operated Gage No. 11512000 on Fall Creek a short distance downstream of the Fall Creek powerhouse, the fish hatchery, and the City of Yreka intakes during most of the period between 1933 and 1959. From October 1, 2003, until September 30, 2005, Gage No. 11512000 was reactivated, and, during this time, the gage recorded a mean flow of 40 cfs and a minimum flow of 21 cfs. According to data from this gage, flow within Fall Creek does not vary much seasonally due to a reliable baseflow from groundwater springs and typically ranges from 30 to 50 cfs.

The City of Yreka, California, operates a water supply intake downstream of the Fall Creek Powerhouse and withdraws up to 15 cfs (see also Section 2.7.6.2 *Fall Creek Hatchery* of this EIR). Intakes to the currently non-operating Fall Creek rearing facility are downstream from the Yreka water supply intake.

Iron Gate Reservoir

Iron Gate Reservoir is downstream from the Copco No. 2 Dam and also receives water from Jenny and Fall creeks. PacifiCorp operates the Iron Gate Dam complex as a re-regulating facility for peaking operations at the other three hydroelectric power dams. Iron Gate Reservoir is the deepest of the four reservoirs in the Hydroelectric Reach. The total storage at this reservoir is approximately 58,794 acre-feet of which 3,790 acre-feet is available for power production (USBR 2012). Iron Gate Powerhouse, at the base of the dam, has a maximum hydraulic capacity of 1,735 cfs. Cool water is diverted from the reservoir to the Iron Gate Fish Hatchery, downstream from the dam (FERC 2007). USGS Gage No. 11516530 on the Klamath River, downstream from Iron Gate Dam, provides flow monitoring data regarding compliance with biological opinions. Bogus Creek and effluent from the hatchery enter the river upstream of the gage and downstream from the dam (USGS 2009b). Figure 3.6-9 shows Klamath River flows downstream from Iron Gate Dam for water years 1963 to 2015. Data for the same period are summarized in Table 3.6-6. The Lower Klamath Project's effect on peak flow events is discussed in sections 3.6.2.3 *Flood Hydrology* and 3.6.5 *[Flood Hydrology] Potential Impacts and Mitigation*. Recent flows for water years 2009 through 2015 are highlighted in Figure 3.6-10. The earlier highlighted years represent flows under the 2008 and 2010 BiOps. The graph also shows actual flows released in accordance with the current 2013 BiOp, as well as the recent drought years.

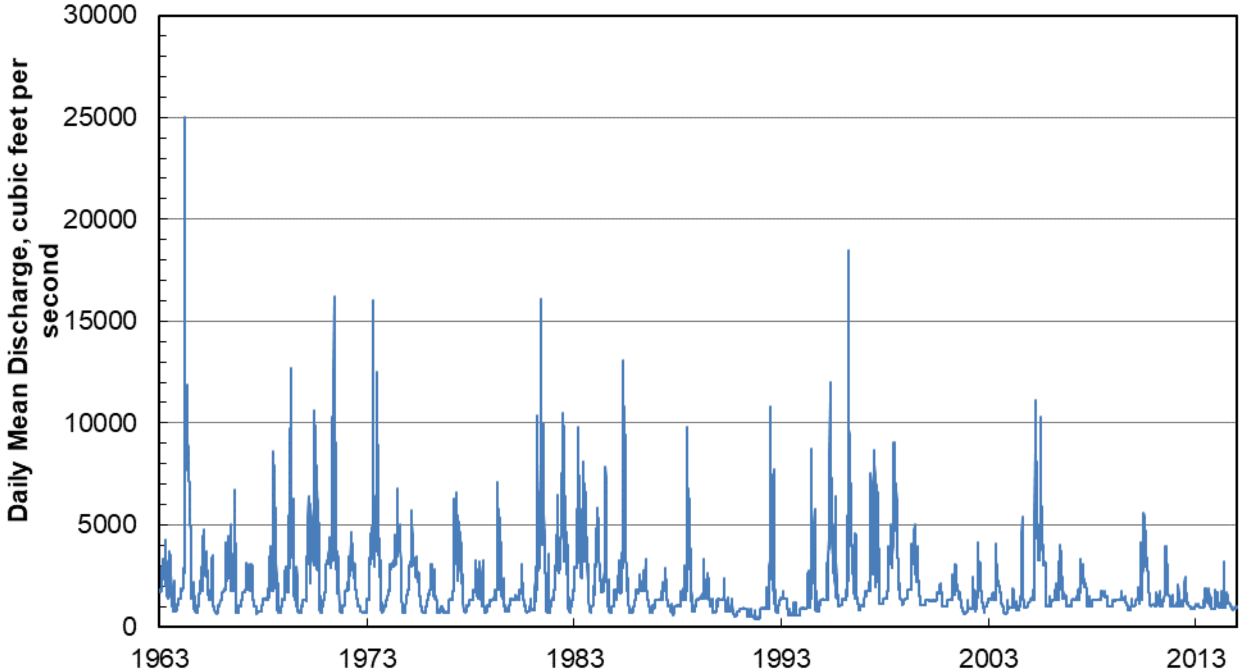

Figure 3.6-9. Discharges for Klamath River Downstream from Iron Gate Dam, 1963–2015.
Source: USGS 2016.

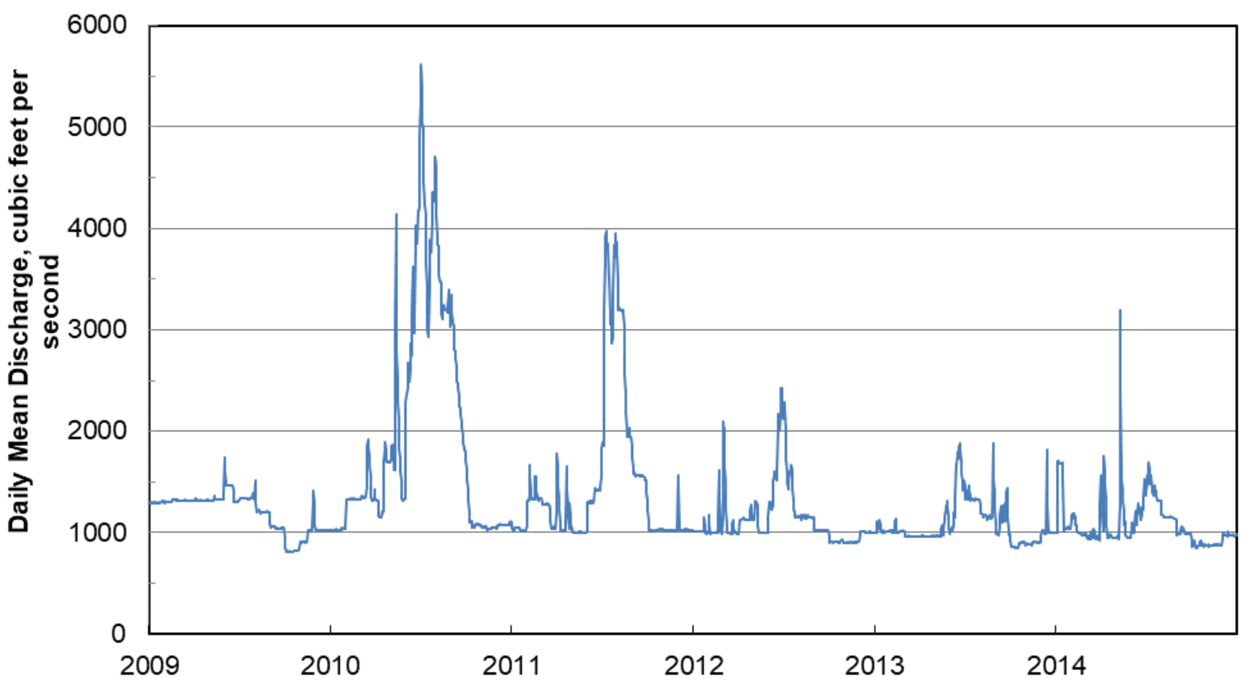

Figure 3.6-10. Discharges for Klamath River Downstream from Iron Gate Dam, 2009–2015.
Source: USGS 2016.

Table 3.6-6. Monthly Discharge Statistics for Klamath River gages.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Yearly
Klamath River at Keno, OR, USGS Gage No. 11509500 (water years 1963 to 2015). Drainage area 3,920 sq. miles, excluding Lost River.													
Mean	1,150	1,465	1,793	2,022	2,104	2,539	2,187	1,551	829	494	649	876	1,468
Median	1,010	1,040	1,310	1,380	1,490	1,940	1,580	1,060	557	444	685	840	954
Max	4,210	5,210	8,160	9,310	9,250	9,780	8,380	6,640	6,640	2,750	1,350	2,240	9,780
Min	253	292	215	248	184	200	203	201	147	131	144	145	131
10 Percent Exceed	1,960	2,640	3,316	4,030	4,484	6,010	4,690	3,322	1,659	782	865	1,310	2,920
90 Percent Exceed	590	620	599	587	449	514	604	448	280	253	332	473	389
Klamath River below J.C. Boyle Powerhouse, USGS Gage No. 11510700 (water years 1963 to 2004). Drainage area 4,080 sq. miles, excluding Lost River													
Mean	1,383	1,678	2,010	2,243	2,327	2,776	2,446	1,836	1,089	738	889	1,113	1,708
Median	1,260	1,290	1,530	1,620	1,760	2,200	1,920	1,370	813	700	938	1,090	1,210
Max	4,170	5,100	8,260	9,860	10,200	10,800	8,660	6,790	6,740	3,070	1,650	2,600	10,800
Min	320	346	342	318	316	313	306	317	321	309	302	309	302
10 Percent Exceed	2,186	2,810	3,526	3,964	4,502	6,080	4,860	3,590	1,920	1,050	1,140	1,560	3,180
90 Percent Exceed	812	840	814	801	666	754.4	857	694	520	407	556	704	633
Fall Creek near Copco, CA, USGS Gage No. 11512000 (water years 1933 to 1959). Drainage area 15 sq. miles													
Mean	35	37	43	46	51	49	45	38	35	34	33	34	40
Median	34	36	37	40	45	46	44	36	33	33	32	33	36
Max	77	137	474	249	200	130	187	65	58	52	47	52	474
Min	27	26	28	28	27	29	28	25	24	24	24	24	24
10 Percent Exceed	44	45	57	65	75	69	61	49	44	42	43	44	55
90 Percent Exceed	28	30	30	30	31	32	31	29	28	28	27	28	29
Klamath River below Iron Gate Dam, CA, USGS Gage No. 11516530 (water years 1963 to 2015). Drainage area 4,630 sq. miles, excluding Lost River													
Mean	1,512	1,861	2,354	2,684	2,791	3,295	2,894	2,153	1,244	837	973	1,221	1,981
Median	1,340	1,370	1,750	1,820	1,950	2,580	2,220	1,670	960	743	1,020	1,310	1,340
Max	4,550	5,830	25,000	18,500	16,100	16,200	12,500	6,950	7,710	3,570	1,650	2,500	25,000
Min	846	848	865	598	508	495	508	484	402	406	389	408	389
10 Percent Exceed	1,900	3,120	4,236	5,052	5,452	7,050	5,689	4,210	2,090	1,060	1,070	1,589	3,780
90 Percent Exceed	949	941	964	1,020	934	999	1,290	1,010	715	690	719	893	746

Note:
All data are shown in cubic feet per second.
Source: USGS 2016

Table 3.6-7 shows the ramping rate criteria for Iron Gate established in the 1961 FERC license amendment and the 2013 BiOp (NMFS and USFWS 2013).

Table 3.6-7. Ramping Rate Requirements for Iron Gate Dam.

Flow Range	Maximum Decrease	Source
General	250 cfs per hour or 3 inches per hour whichever is less	FERC 1961 license amendment
Greater than 3,000 cfs	Follows a 3-day moving average of net inflow into UKL and accretions between Link River Dam and Iron Gate Dam	NMFS & USFW 2013
Above 1,750 cfs and less than or equal to 3,000 cfs	not more than 125 cfs per 4-hour period and not exceeding 300 cfs per 24 hours	NMFS & USFW 2013
1,750 cfs or less	not more than 50 cfs per 2-hour period and not exceeding 150 cfs per 24-hour period	NMFS & USFW 2013

Source: NMFS and USFWS 2013

Flows downstream from Iron Gate Dam are the result of the Link River Dam releases from Upper Klamath Lake, Link River Dam to Iron Gate Dam flow accretions, and management of the Klamath Hydroelectric Project by PacifiCorp. Since approximately 1997, Iron Gate Dam minimum flow releases have been stipulated by various BiOps, which was discussed in detail in the 2007 FEIS as well as the 2008 and 2010 BiOps (FERC 2007).

In 2008, the USFWS issued a BiOp to USBR on the operation and maintenance of USBR's Klamath Irrigation Project. This BiOp outlined measures to improve the habitat for the Lost River sucker and shortnose sucker, affected by USBR's Klamath Irrigation Project operations. Among other measures to protect the suckers, the BiOp required that specific surface elevations of Upper Klamath Lake be maintained.

In 2010, NMFS also issued a BiOp to USBR, requiring releases from USBR's Klamath Irrigation Project to release specified rates of flow for the Klamath River downstream from Iron Gate Dam, based on the habitat needs of coho salmon. Target flow rates in the Klamath River downstream from Iron Gate Dam varied by month and were dependent in part on the amount of water entering Upper Klamath Lake.

Currently, flow releases at Iron Gate Dam are dictated by the 2013 BiOp and court-ordered flushing flows, which were designed to protect federally listed coho salmon, Lost River sucker, and shortnose sucker (NMFS and USFWS 2013, U.S. District Court 2017c). The court-ordered flushing flows became effective in February 2017, after the Notice of Preparation (NOP) was filed by the State Water Board in December 2016, and are therefore not part of the Existing Conditions for the Proposed Project. This section notes, and as appropriate discusses, the potential differences to the Existing Conditions and the impact analysis based on the newer flow requirements. The current flow regime does not result in any changes to the findings of significance and does not result in any changes regarding mitigation measures.

USBR uses the monthly 50 percent exceedance inflow forecasts from the Natural Resources Conservation Service (NRCS) as the basis for Klamath Irrigation Project operations to manage Upper Klamath Lake and the Klamath River during the spring-summer irrigation season (March 1 through September 30). To estimate the water supply available from Upper Klamath Lake and the Klamath River, USBR relies on actual inflows to Upper Klamath Lake and NRCS inflow forecasts for Upper Klamath Lake to determine three key operational values: (1) the volume of water to be reserved in Upper Klamath Lake to maintain lake elevations analyzed in the BiOp; (2) the volume of water designated for the Klamath River, referred to as the environmental water account (EWA); and (3) the volume of water available for delivery for irrigation purposes to the Klamath Irrigation Project (USBR 2016).

USBR makes a preliminary calculation of these three operational values on March 1; however, those estimates are subject to change, based on actual Upper Klamath Lake inflows after March 1 and subsequent NRCS inflow forecasts. USBR recalculates these values on April 1, based on actual Upper Klamath Lake inflows observed in March and NRCS Upper Klamath Lake inflow forecast for April 1 to September 30. This April 1 calculation establishes the initial volume of water available for irrigation from the Upper Klamath Lake and the Klamath River during the spring-summer irrigation season.

The 2013 BiOp established average daily minimum target flows below Iron Gate Dam. Maximum target flows are established for July, August, and September, and are based on the EWA volumes. These target flows are summarized in Table 3.6-8.

In addition, increases to the target flows in Table 3.6-8 can occur in late August or early September to support the Yurok Tribal Boat Dance Ceremony. To ensure adequate flow for the Yurok Tribal Boat Dance Ceremony, which occurs during even calendar years, flow releases at Iron Gate Dam can be increased. The volume of water required for the ceremony is estimated to be between 2,000 and 4,000 acre-feet depending on real-time hydrologic conditions (NMFW and USFWS 2013). Deviations to the flow targets in Table 3.6-8 can also occur based on other circumstances, such as large fish disease events or flood hazard risks.

Table 3.6-8. Iron Gate Dam Target Flow Release Criteria According to the 2013 Biological Opinion.

Month	NMFS & USFWS 2013 Biological Opinions Iron Gate Target Flows (cfs)[2]	
	Average Daily Minimum	Average Daily Maximum[3]
April	1,325	--
May	1,175	--
June	1,025	--
July	900	1,000 cfs @ EWA = 320,000 acre-feet 1,500 cfs @ EWA ≥ 1,500,000 acre-feet
August	900	1,050 cfs @ EWA = 320,000 acre-feet 1,250 cfs @ EWA ≥ 1,500,000 acre-feet
September	1,000	1,100 cfs @ EWA = 320,000 acre-feet 1,350 cfs @ EWA ≥ 1,500,000 acre-feet
October	1,000	--
November	1,000	--
December	950	--
January	950	--
February	950	--
March	1,000	--

Notes:
"--" none specified, but regulated per ramping rates shown in Table 3.6-7.
cfs = cubic feet per second; EWA = Environmental Water Account
[1] Source: FERC 2007
[2] Source: NMFS and USFWS 2013a
[3] In late August/early September during even calendar years, flow releases at Iron Gate Dam may be increased to support the Yurok Tribal Boat Dance Ceremony. The volume of water required is estimated to be 2,000–4,000 acre-feet depending on real-time hydrologic conditions.
Source: NMFS and USFWS 2013

Mid Klamath Basin

The Middle Klamath Basin includes the area downstream from Iron Gate Dam to the confluence of the Trinity River, which includes 150 miles of river. The major tributaries entering the Klamath River along these reaches include the Shasta, Scott, and Salmon rivers. The Klamath Basin is heavily influenced by these three rivers because they provide 44 percent of the average annual runoff (FERC 2007). Below are brief descriptions of these three rivers and other reaches along the Middle Klamath River.

Shasta River

The Shasta River enters the Klamath River at RM 179.5, 13.5 miles downstream from Iron Gate Dam. The Shasta River watershed includes the glaciated slopes of Mount Shasta but is largely rangeland with substantial amounts of irrigated pastureland and agricultural area. The average precipitation in the watershed varies greatly with exposure and elevation but is about 15 inches per year due to the rain shadow effects of the mountains to the west of the watershed.

The hydrograph for the Shasta River near the confluence with the Klamath River shows a peak in the winter and minimum median flows under 40 cfs during July and August (see Table 3.6-9). The current hydrology of the Shasta River is affected by surface-water diversions, alluvial pumping, and the Dwinnell Dam which creates Lake Shastina. Historically, springs and seeps dominated the hydrograph of the Shasta River resulting in a cool and stable river flow. Dwinnell Dam, about 25 miles upstream from the Klamath River at a location that controls 15 percent of the total drainage area of the Shasta River, was constructed in 1928 and has a normal storage capacity of 50,000 acre-feet.

The majority of the water in Lake Shastina is retained during the winter and early spring and then used for irrigation during the later spring and summer. A 2013 settlement between the Karuk Tribe and the Montague Water Conservation District mandates a flow release of 2,250 to 3,000 acre-feet per year from Lake Shastina to support endangered coho salmon. Farther downstream, there are seven major diversion dams and numerous smaller dams or weirs on the Shasta River and its tributaries. When these diversions are in operation during the irrigation season, they substantially and rapidly reduce flows in the mainstem causing complete dewatering of the main channel in some reaches of the river during the late summer of dry years.

Scott River

The Scott River enters the Klamath River at RM 145.1, 47.1 miles downstream from Iron Gate Dam. The Scott River watershed includes the heavily forested and relatively wet Salmon Mountains on its western divide, but these mountains create a rain shadow for the rest of the watershed. Similar to the Shasta River Valley, many areas in the Scott River Valley have been extensively altered for grazing and agriculture. Although the Scott River watershed is almost the same size as the Shasta River watershed, the hydrograph for the Scott River near the confluence with the Klamath River has four to five times higher median monthly flows in the winter and spring months (see Table 3.6-6). Somewhat similar to the Shasta River, the minimum monthly median flows near 50 cfs occur during August and September.

Klamath River at Seiad Valley

A USGS flow gage is on the Klamath River at Seiad Valley, downstream from its confluence with the Scott River. During the low flow months of August through November, approximately 75 percent of the water flowing past this gage is attributed to Iron Gate Dam releases. During the months of April through June approximately 50 percent of the water flowing past this gage is attributable to Iron Gate Dam releases (FERC 2007). Figure 3.6-11 shows daily flow at the Klamath River at Seiad Valley from water years 1963 to 2015.

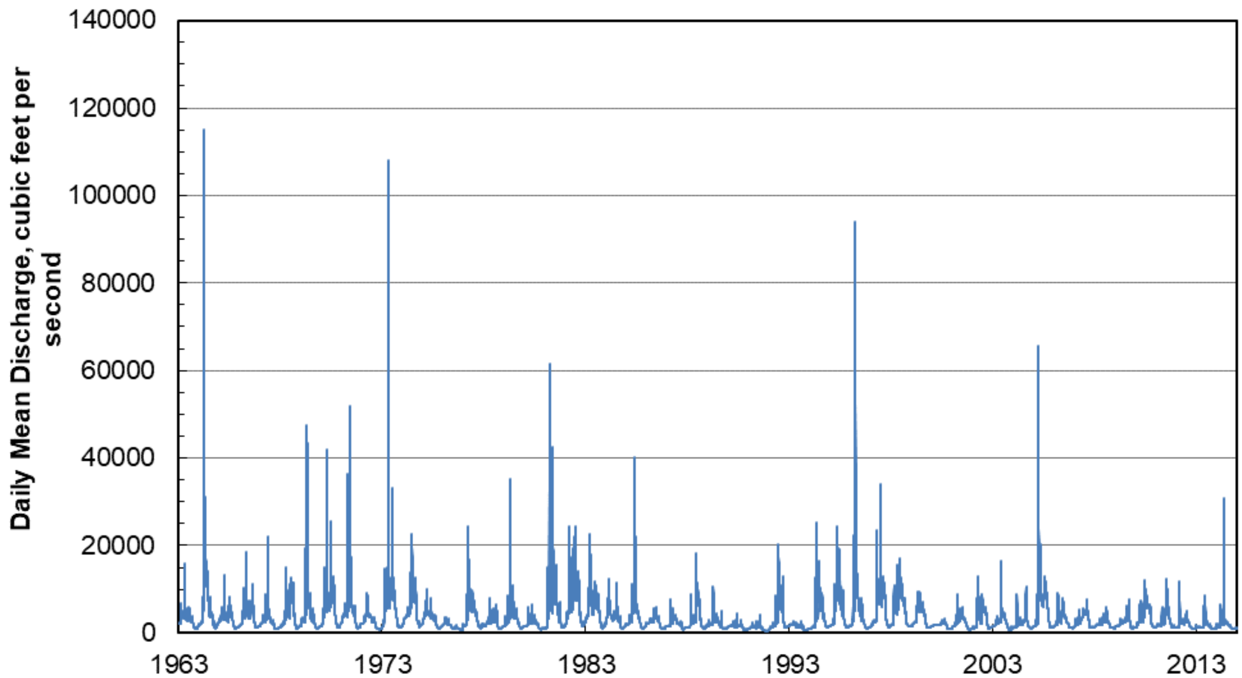

Figure 3.6-11. Discharge for Klamath River at Seiad Valley, 1963–2015. Source: USGS 2016.

Salmon River

Approximately 77 miles downstream from the Scott and Klamath rivers confluence, the Salmon River enters the Klamath River at RM 66.3. The Salmon River flows through the Klamath National Forest and many designated wilderness areas. The region surrounding the Salmon River is mainly forested with some agricultural activity. High monthly average flows (3,375 cfs) occur in January, which is the winter peak for flooding as rain and rain-on-snow events occur (see Table 3.6-6). In April and May, the Salmon River has a high monthly average flow (2,660 and 2,630 cfs, respectively) from snowmelt at higher elevations. The Salmon River has its lowest monthly average flow at about 200 cfs in September, which is later than for other tributaries upstream including the Shasta River where lowest monthly average flow occurs in July (FERC 2007).

Klamath River at Orleans

USGS Gage No. 11523000 is at Orleans, downstream from the confluence of the Salmon and Klamath rivers and other smaller tributaries within the Middle Klamath Basin. This area receives a high amount of precipitation compared to other reaches upstream of the Shasta River; therefore, higher flows than in upstream reaches occur here in the winter and spring months. Iron Gate Dam releases account for approximately 20 percent of the flow during these high flow periods and over 50 percent of the flow during the late summer and fall (FERC 2007). Figure 3.6-12 shows daily flow at USGS Gage No. 11523000 from water years 1963 to 2015, the same period of record summarized for this gage in Table 3.6-6.

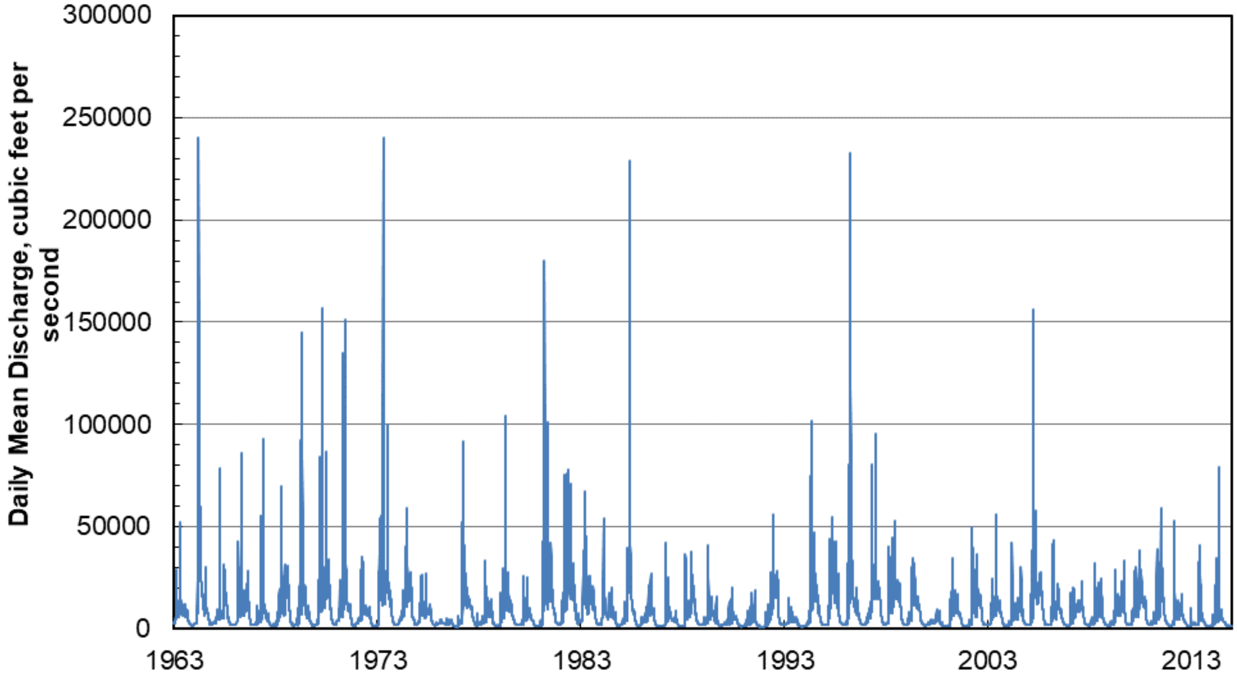

Figure 3.6-12. Discharge for Klamath River at Orleans, 1963–2015. Source: USGS 2016.

Table 3.6-9. Monthly Discharge Statistics for USGS Gages along the Lower Klamath River and for the Shasta, Scott, Salmon, and Trinity Rivers.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Yearly
Shasta River near Yreka, CA, USGS Gage No. 11517500 (water years 1963 through 2015) Gage data prorated by 1.0485 to the confluence with the Klamath. Shasta River drainage area 800 square miles.													
Mean	158	207	295	366	334	326	206	150	104	49	40	71	192
Median	153	191	212	237	252	248	159	115	79	35	31	63	161
Max	1,311	910	10,904	8,828	3,796	2,726	2,768	1,143	969	285	245	475	10,904
Min	34	125	138	146	148	48	18	13	6	2	2	5	2
10 Percent Exceedance	208	262	421	639	564	550	403	287	195	101	74	126	354
90 Percent Exceedance	107	151	163	170	178	158	56	47	26	15	15	24	28
Scott River at Fort Jones, CA, USGS Gage No. 11519500 (water years 1963 through 2015). Gage data prorated by 1.2557 to the confluence of the Klamath River. Scott River drainage area 820 square miles.													
Mean	110	377	1,018	1,319	1,307	1,332	1,210	1,365	832	205	58	52	763
Median	73	143	416	635	856	997	1,087	1,182	600	116	43	46	357
Max	8,514	8,062	49,600	38,801	16,952	16,324	8,212	6,065	5,776	1,771	701	556	49,600
Min	5	6	16	68	92	80	63	88	12	8	5	4	4
10 Percent Exceedance	147	867	2,373	2,788	2,662	2,386	2,135	2,562	1,920	526	116	92	1,871
90 Percent Exceedance	20	60	108	154	297	471	412	389	117	25	9	9	30
Klamath River at Seiad Valley, CA, USGS Gage No. 11520500 (water years 1963 to 2015). Drainage area 6,940 square miles, does not include Lost River.													
Mean	1,889	2,727	4,470	5,599	5,490	6,101	5,355	4,628	2,780	1,336	1,178	1,425	3,573
Median	1,670	2,070	2,970	3,580	3,940	4,730	4,655	3,950	2,230	1,160	1,210	1,460	2,250
Max	14,900	15,000	115,000	108,000	42,400	51,900	31,600	14,100	12,900	7,200	2,650	2,710	115,000
Min	963	1,080	1,180	1,210	1,070	1,020	1,070	954	603	552	398	464	398
10 Percent Exceedance	2,662	4,919	7,846	11,500	10,700	12,300	9,569	8,460	5,170	2,010	1,456	1,940	7,520
90 Percent Exceedance	1,220	1,350	1,668	1,824	1,860	2,124	2,141	1,734	1,190	880	816	986	1,120
Salmon River at Somes Bar, CA, USGS Gage No. 11522500 (water years 1963 to 2015). Drainage area of the gage and the Salmon River 751 square miles.													
Mean	346	1,112	2,523	3,222	2,902	3,075	2,874	2,941	1,785	613	269	208	1,818
Median	208	464	1,330	1,910	2,100	2,360	2,670	2,690	1,380	474	246	192	1,050
Max	12,300	22,000	10,0000	64,400	31,200	43,600	15,200	11,000	12,000	4,160	3,950	3,440	100,000
Min	83	119	179	182	182	281	399	546	224	107	72	60	60
10 Percent Exceedance	544	2,639	5,916	6,380	5,392	5,216	4,710	5,020	3,649	1,180	417	275	4,150
90 Percent Exceedance	126	205	331	543	910	1,160	1,231	1,040	502	225	138	119	185

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Yearly
Klamath River at Orleans, CA, USGS Gage No. 11523000 (water years 1963 to 2015). Drainage area 8,475 square miles does not include Lost River.													
Mean	2,721	5,801	11,669	14,832	14,059	14,491	12,491	10,791	6,175	2,591	1,832	1,940	8,257
Median	2,220	3,490	6,700	8,920	10,200	11,700	11,100	9,410	4,820	2,240	1,840	1,940	4,710
Max	33,400	83,900	240,000	240,000	229,000	151,000	72,900	34,000	33,400	12,200	10,400	10,400	240,000
Min	1,110	1,510	1,820	1,770	1,980	2,240	2,330	1,930	1380	824	652	652	652
10 Percent Exceedance	4,042	12,700	25,060	30,100	25,900	25,660	21,500	18,900	11,990	4,256	2,390	2,459	18,500
90 Percent Exceedance	1,570	2,160	2,660	3,408	4,476	5,294	5,012	3,760	2,301	1,434	1,240	1,280	1,710
Trinity River at Hoopa, CA, USGS Gage No. 11530000 (water years 1963 to 2015. Gage data prorated by 1.01647 to the confluence with the Klamath River. Trinity River drainage area 2,900 square miles. Post-Trinity River diversion.													
Mean	926	2,674	6,987	10,019	9,622	9,598	7,041	5,619	3,121	1,379	815	739	4,859
Median	719	1,118	3,415	5,794	6,577	6,973	5,428	4,472	2,287	1,108	743	684	2,287
Max	23,074	36,491	17,0767	11,9943	99,919	86,603	45,843	29,173	15,755	5,855	6,170	3,802	170,767
Min	311	498	511	555	630	1,047	986	1,027	422	275	248	292	248
10 Percent Exceedance	1,256	6,404	16,629	23,176	20,960	18,601	13,011	10,876	6,057	2,507	1,220	1,037	11,384
90 Percent Exceedance	514	693	905	1,407	2,476	2,972	2,491	2,155	1,170	686	502	460	639
Klamath River near Klamath, CA, USGS Gage No. 11530500 (water years 1963 to 2015). Drainage area 12,100 square miles, does not include Lost River.													
Mean	4,593	12,357	25,188	32,056	30,769	31,741	25,257	19,709	11,256	4,754	3,130	3,171	16,914
Median	3,600	6,280	14,600	20,000	22,650	24,600	20,800	16,800	8,880	4,000	2,980	3,000	9,440
Max	79,000	140,000	420,000	397,000	404,000	317,000	173,000	71,500	63,100	25,100	20,900	20,100	420,000
Min	1,910	2,320	3,070	2,840	3,300	5,030	4,410	4,680	2,100	1,440	1,340	1,310	1,310
10 Percent Exceedance	6,429	28,000	5,7200	6,8600	6,1800	5,9200	4,3390	3,5380	2,0500	7,900	4,268	4,150	38,000
90 Percent Exceedance	2,630	3,520	4,656	6,892	9,902	12,100	10,100	8,180	4,431	2,580	2,070	2,100	2,830

Notes:

For water years 1963 to 2015; data for December 31, 1994 to January 6, 1995 and October 30, 1995 to September 30, 1997 are missing.

Source: USGS 2016

Lower Klamath Basin

Trinity River

The Trinity River enters the Klamath River at RM 43.3, 150 miles downstream of Iron Gate Dam. The Trinity River is the largest tributary to the Klamath River. The Trinity River watershed is generally wet, steep, forested, and largely federally owned within several national forest and wilderness areas. As shown in Table 3.6-9, the Trinity River hydrograph at the confluence with the Klamath River has peak median monthly flows in February and March near 7,000 cfs, gradually declining to about 600 cfs in September.

A main feature of the Trinity River watershed is Trinity Lake. This reservoir has a storage capacity of 2.4 million acre-feet and is located 119 miles upstream from the Klamath River along the main branch of the Trinity River. Both Trinity Lake and the much smaller downstream Lewiston Reservoir were constructed in the early 1960's as part of the Central Valley Project's Trinity River Division (TRD). For the first 10 years of full operation, an average of nearly 90 percent or 1.2 million acre-feet of the annual river flow at the Lewiston Reservoir (drainage area of 692 square miles) was diverted via the Clear Creek Tunnel to Whiskeytown Lake and then to the Sacramento River system (FERC 2007). The California Department of Water Resources estimates that about 1.1 million acre-feet per year were diverted during 1964 to 1986 and 0.73 million acre-feet during 1987 to 2000.

The current flow release program from Lewiston Dam to the Trinity River is based on the Trinity River Mainstem Fishery Restoration EIS, completed in October 2000. In December 2000, USBR issued the Record of Decision (Trinity ROD) for the Trinity River Mainstem Fishery Restoration, but these flows did not go into full effect until November 2004.

Figure 3.6-13 shows the daily flow from the Trinity River at the confluence with the Klamath River for water years 1963 to 2015. Data for this same period that represents post-TRD operations are summarized in Table 3.6-9.

The Trinity ROD directed for approximately 50 percent of the Trinity River's flow to remain in the river (i.e., would not be diverted to the Central Valley) and for the Trinity River Restoration Program (2016) to recommend how water was to be released for restoration of the river and its fisheries.

Restoration flows are intended to: clean spawning gravels, build gravel/cobble bars; scour sand out of pools, provide adequate temperature and habitat conditions for fish and wildlife at different life stages, control riparian vegetation, and perform many other ecological functions. To mimic some of the inter-annual variation that is naturally found within the Trinity Basin, the Trinity ROD defines five water year types along with a minimum volume of water to be released into the Trinity River for each year type, as summarized in Table 3.6-10.

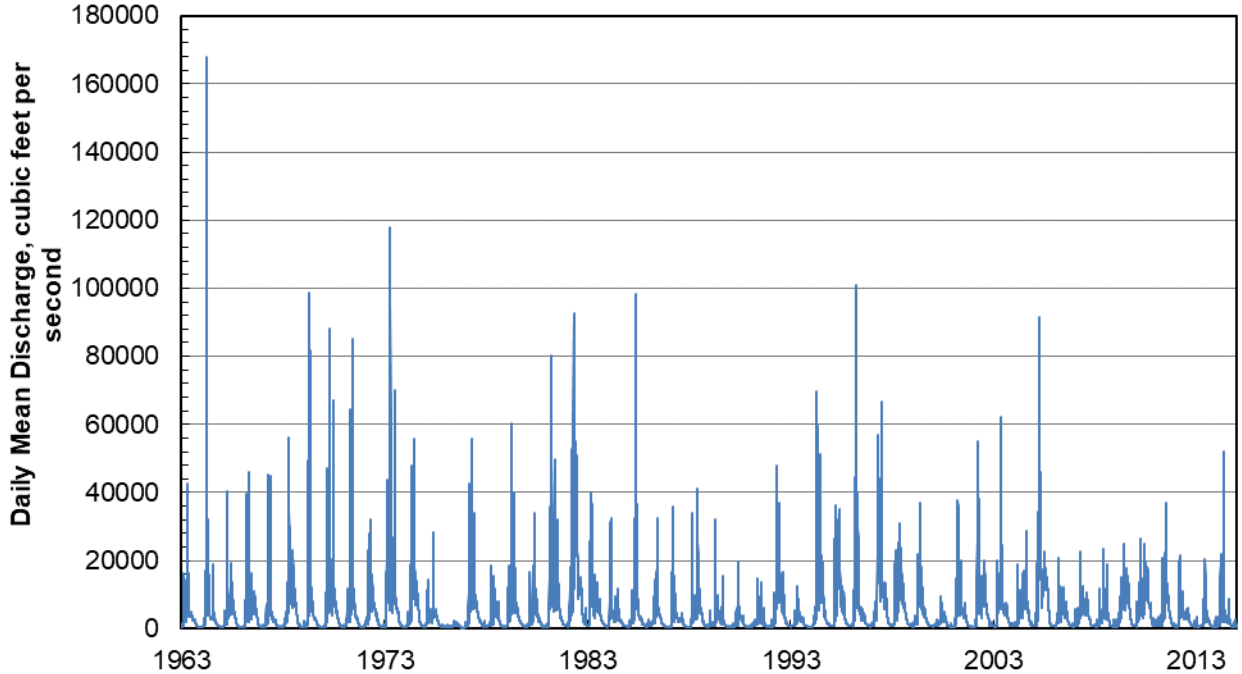

Figure 3.6-13. Daily Inflow from the Trinity River at the Confluence with the Klamath River, 1963–2015. Source: USGS 2016.

Table 3.6-10. Minimum Releases for Trinity River Restoration.

Water Year Type	Minimum Release Volume (acre-feet)
Critically Dry	369,000
Dry	453,000
Normal	647,000
Wet	701,000
Extremely Wet	815,000

Source: Trinity River Restoration Program 2016

Typical flow releases for each month of the five water year types are determined based on forecasted inflows to Trinity Reservoir on April 1. Each year, the water not allocated to the river for restoration purposes is available for export to the Central Valley Project for water supply and power generation.

During the recent drought from 2012 to 2016, USBR's drought plans included flow augmentation for the lower Klamath River from the Trinity Reservoir in addition to curtailing deliveries to Klamath Irrigation Project contracts. Abnormally dry hydrologic conditions led to very low Klamath River accretion forecasts, prompting concerns of a disease outbreak. Tribes, sport-fishermen groups, and other fishery advocates formally requested that USBR take action. Chinook in-river run size projections were at all-time highs in 2012, 2013, and 2014 (USBR 2015). Flow augmentation during these three drought years was as follows:

- **2012**: Ultimately 39,000 acre-feet was released for preventative purposes and no emergency releases were required. No substantial disease outbreak was noted by any tribes or fishery resource agencies during the return period. The fall Chinook return, post-season estimate was 292,000 adults.

- **2013**: Flows were augmented to a rate of 2,800 cfs in the lower Klamath River from August 15 through September 21. Ultimately 17,500 acre-feet was released for preventative purposes in 2013, and no emergency releases were required. No substantial disease outbreak occurred, although the Yurok Tribe reported that several fish had died from Columnaris. The post-season run size estimate was 165,100 adults.
- **2014**: Outbreaks of Ich drove the need for two emergency releases from Lewiston Dam. The volume of water initially released under the emergency criteria (from August 23 through September 16) totaled approximately 22,700 acre-feet, while the emergency flow doubling that (from September 17 through September 24), excluding ramping, totaled 41,300 acre-feet, for a grand total of 64,000 acre-feet. The fall Chinook return, post-season estimate was 160,000 adults.

USBR reported that the average volume released from Trinity Reservoir for augmentation in previous and recent dry periods (i.e., 2003, 2004, 2012, 2013, and 2014) was 38,963 acre-feet. USBR anticipates that a similar quantity will be sufficient in the majority of years when augmentation is required. However, as demonstrated by conditions experienced in 2014, the volume of release may exceed 40,000 acre-feet in any given year (USBR 2015).

Klamath River at Klamath
USGS Gage No. 11530500 is near the mouth of the Klamath River where it meets the estuary within the Lower Klamath watershed (see Table 3.6-9). During the September to October low flow periods, the releases from Iron Gate Dam account for approximately 40 percent of flow. However, the area surrounding the Klamath River reach downstream from its confluence with the Trinity River receives a heavy amount of precipitation, and during the winter months approximately 85 percent of the flow comes from other sources than Iron Gate Dam releases (FERC 2007).

Figure 3.6-14 shows daily flow from water years 1963 to 2015. Flows for July 2014 in the Lower Klamath River tied with 1994 for the second lowest on record (period of record from 1963 to 2015, with 1992 also similar). However, releases from Iron Gate Dam on the Klamath River were 300 cfs lower in July 1994, compared to 2014 (with Lewiston Dam releases on the Trinity River being equivalent), meaning that accretions were approximately 300 cfs lower in July 2014, compared to the exceptionally dry year of 1994. The extreme drought year of 1977 had the driest July and September on record, yet flows increased on September 20 of that year, to over 3,200 cfs from precipitation. In 1994, flows also increased in September (on September 1) to approximately 2,000 cfs (Strange 2014).

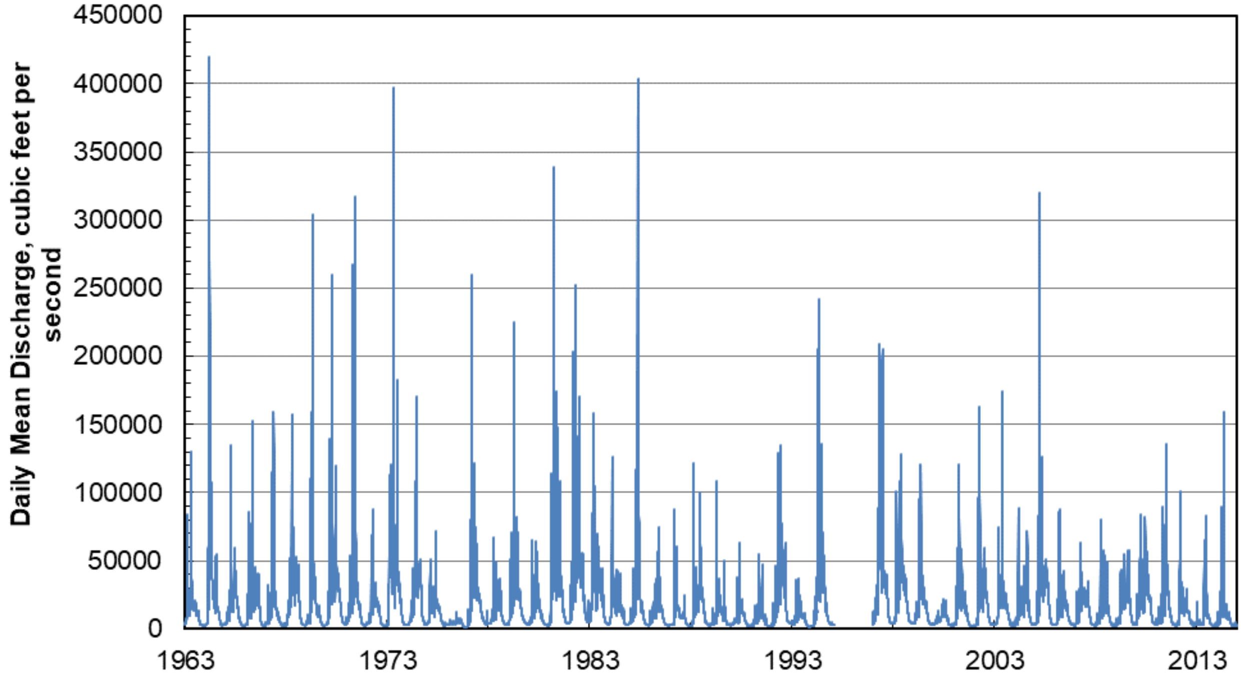

Figure 3.6-14. Discharge for Klamath River at Klamath, 1963–2015. Source: USGS 2016.

Klamath River Estuary

The Klamath River Estuary spans approximately four to five miles upstream of the mouth. The tidal influence normally extends approximately four miles upstream of the mouth during high tides greater than six feet upstream of the U.S. Highway 101 bridge. Past studies have observed the formation of a sill at the river mouth in late summer or early fall causing a standing water backup up to six miles upstream. During high tides saltwater was observed in the summer and early fall from the mouth upstream ranging approximately 2.5 to four miles depending on the time period samples were taken. The saltwater recedes during low tides (Wallace 1998).

3.6.2.3 Flood Hydrology

The active storage capacity at Upper Klamath Lake is approximately 579,200 acre-feet and includes areas restored by levee and dike breaches at Agency Lake, Barnes Ranch, Tulana Farms, and Goose Bay (USBR 2012). Active storage at Keno, J.C. Boyle, Copco No. 1, Copco No. 2 and Iron Gate reservoirs totals approximately 12,244 acre-feet (FERC 2007). Approximately 98 percent of the active surface water storage along the Klamath River is provided by Upper Klamath Lake behind Link River Dam. Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams provide approximately two percent of the active storage on the river.

Flood frequency analyses for 10-year to 100-year events were performed for seven USGS gages along the Klamath River. The analysis used a Log-Pearson III distribution and methods consistent with USGS Bulletin 17B (Table 3.6-11) (USGS 1982). The flows at Keno, J.C. Boyle, and Copco gages are highly regulated by impoundments and diversions upstream of the Keno gage. To better model those effects and improve the fit of the frequency curve to the data, a gage base discharge was applied to censor the data. This was done based on the assumption that the peak discharges above the gage base discharge represent what would be expected during unregulated conditions. The analyses do not include peaks below the gage base discharge to estimate the frequency curve statistics because they are regulated and cannot be modeled using the same distribution. Following the procedures of USBR (2012) the gage base discharges used for Keno, J.C. Boyle, and Copco were 4,000 cfs, 4,000 cfs, and 5,400 cfs, respectively. The Iron Gate, Seiad Valley, Orleans, and Klamath gages are not significantly impacted by the regulation upstream of Keno and therefore the data from these gages were not censored for the flood frequency analyses.

To create a common period of record, the gage records at J.C. Boyle and Copco were extended based on correlation to Keno. The gage data at Keno was correlated to the J.C. Boyle and Copco data for the overlapping years of record when the peak discharges at both gages were from the same flood event. The Iron Gate, Seiad Valley, Orleans, and Klamath gage records do not correlate well with the Keno record and thus they were not extended.

Table 3.6-11. Annual Flood Frequency Analysis on Klamath River for 10-Year to 100-Year Flood Events.

Gaging Station	Drainage Area (miles²)	Gage Base[1] (cfs)	Peak Flood Discharge (cfs)			
			10-Year	25-Year	50-Year	100-Year
United State Geologic Service (USGS) Gage No. 11509500, Klamath River at Keno, OR	3,920	4,000	9,729	11,071	12,010	12,907
USGS Gage No. 11510700, Klamath River below J.C. Boyle Power Plant, OR	4,080	4,000	10,362	12,063	13,301	14,518
USGS Gage No. 11512500, Klamath River below Fall Creek near Copco, CA	4,370	5,400	11,910	13,543	14,702	15,821
USGS Gage No. 11516530, Klamath River below Iron Gate Dam, CA	4,630	N/A	14,854	20,867	25,985	31,648
USGS Gage No. 11520500, Klamath River near Seiad Valley, CA	6,940	N/A	53,300	85,784	118,058	158,619
USGS Gage No. 11523000, Klamath River at Orleans, CA	8,475	N/A	157,938	221,107	274,019	331,731

Gaging Station	Drainage Area (miles²)	Gage Base[1] (cfs)	Peak Flood Discharge (cfs)			
			10-Year	25-Year	50-Year	100-Year
USGS Gage No. 11530500, Klamath River near Klamath, CA	12,100	N/A	302,484	401,814	481,078	564,372

Data Source: USGS 2017
Notes:
[1]Gage base is a threshold above which peak discharges represent what would be expected during unregulated conditions. Peak discharges below the gage base are influenced by regulation and are omitted from the analysis.
Periods of record (gaged and correlated) (water years):
Keno 1905–1913, 1930–2016
J.C. Boyle 1959–2016. 1905–1913 and 1930–1958 correlated based on Keno gage.
Copco, 1924–1961. 1905–1913 and 1962–2016 correlated based on Keno gage.
Iron Gate 1961–2016
Seiad Valley 1913–1925, 1952–2016
Orleans 1927–2016
Klamath 1911–1927, 1932–1994, 1996–2016

The flood frequency analyses use the most recently published USGS streamflow data (Table 3.6-11) to provide an update to USBR (2012), which conducted comparable flood frequency analyses to support the hydrologic and hydraulic modeling of 100-year floodplain inundation (presented in Appendix K). USBR (2012) states that under the Proposed Project during a 100-year event the largest water surface elevation increases would be approximately 1.5 feet downstream of Iron Gate Dam, and that the error in computed water surface elevations is one to two feet at most modeled cross sections. USBR (2012) acknowledges their computed water surface elevation increases are conservative overestimates. The 100-year peak flow estimate for Iron Gate Dam (the flow used in model calculations to compare the Proposed Project with existing conditions) presented in Table 3.6-11 differs from that given in USBR (2012) by less than one percent.

Results of the flood frequency analyses indicate that peak flows at Iron Gate Dam are substantially greater than peak flows at J.C. Boyle Dam (Table 3.6-11). This is because of flows from the tributaries that enter the Klamath River between the two dams. In particular, Jenny Creek contributes a large amount to the peak flow during the winter and spring months. The watershed area of Jenny Creek is 210 square miles, and it is the largest single tributary to the Klamath River between Keno Dam and Iron Gate Dam (USBR 2012).

During extremely wet years, surface water elevations rise in Upper Klamath Lake. Agency Lake, Barnes Ranch, and the Nature Conservancy-owned lands provide over 108,000 acre-feet of storage around and near Upper Klamath Lake due to recent breaching of local dikes and levees, which can help to reduce flooding downstream. In contrast, there is minimal surplus storage in the Lower Klamath Project to help control flooding downstream of Iron Gate Dam. During wet years, decreased irrigation demands in the upper basin may allow for more water to remain in Upper Klamath Lake for use later in the year. The amount of water retained in Upper Klamath Lake is determined under the 2013 BiOp and depends on decisions related to ESA-listed suckers and the magnitude of spring flushing flows and fall migration flows downstream of Iron Gate Dam (NMFS and USFWS 2013) (see also Section 3.1.6.1 Klamath River Flows under the

Klamath Irrigation Project's 2013 BiOp Flows). The 2013 BiOp also includes provisions for average and wet years that increase minimum flow requirements at Iron Gate Dam and surface water elevations in Upper Klamath Lake to more closely mimic natural flow and lake-level conditions and provide storage for surplus water (NMFS and USFWS 2013).

3.6.2.4 Risks of Dam Failure

Dams are man-made structures and do include some risk of failure that could result in flooding downstream. According to the Association of State Dam Safety Officials (ASDSO), dams fail due to one of five reasons (ASDSO 2011):

1. Overtopping caused by water spilling over the top of dam;
2. Structure failure of materials used in dam construction;
3. Cracking caused by movements like the natural settling of dam;
4. Inadequate maintenance and upkeep; or
5. Piping—when seepage through a dam is not properly filtered and soil particles continue to erode, and form sink holes in the dam or its foundation.

In California, weighted point systems are used during inspections to classify both the hazard or damage potential and condition of the dam. Once classified, the frequency of inspections and return period for hydrology studies are selected. The classifications used for damage potential are extreme, high, moderate and low and refer to the possibility of loss of life and property downstream from the dam if it were to fail. The classifications of the condition of the dam are poor, fair, good, and excellent and are determined based on the age, general condition, and geologic and seismic setting. Dams may be reclassified after improvements or other changes have occurred (ASDSO 2000).

Siskiyou County recently developed a Multi-Jurisdictional Hazard Mitigation Plan which addressed, among other issues, flood and dam failure hazards. Maps are currently available that describe dam inundation areas based on potential failure of J.C. Boyle and Iron Gate dams as well as a domino effect, depicting the inundation area if multiple dams were to fail at the same time (Siskiyou County 2011). FERC staff have conducted safety inspections of the dam structures as part of the licensing program over the past 50 years. Every five years J.C. Boyle, Copco No. 1 and Iron Gate dams are inspected and evaluated by an independent consultant and reports documenting the evaluation are submitted to FERC for review (FERC 2007).

3.6.3 Significance Criteria

Criteria for determining significant impacts on flood hydrology was informed by Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and based on professional judgment. Effects on flood hydrology are considered significant if the Proposed Project would result in exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding, where substantial risk is associated with structures located within the FEMA 100-year floodplain inundation extent. These impacts are broadly divided into short-term flood risks that could occur during reservoir drawdown and long-term, permanent changes to the downstream floodplain elevations (i.e., permanent changes to the FEMA 100-year floodplain) as a result of dam removal.

The potential for changes in flood hydrology and/or in the extent of floodplain inundation to impact aquatic and terrestrial resources are discussed in Sections 3.3 *Aquatic Resources* and 3.5 *Terrestrial Resources*, respectively.

3.6.4 Impacts Analysis Approach

The assessment of the environmental impacts on flood hydrology that would result from implementation of the Proposed Project and its alternatives determines whether changes in stream flows would cause flooding within the Area of Analysis. The impact assessment is based on the USBR's hydrologic and hydraulic modeling, which covers the Proposed Project and the No Project Alternative. USBR used a one-dimensional HEC-RAS model that assessed hydrologic conditions for these two alternatives and analyzed modeling output to determine how frequently the current FEMA floodplain is inundated and how the floodplain could change under the Proposed Project. This information was presented in the *Hydrology, Hydraulics, and Sediment Transport Studies for the Secretary's Determination on Klamath River Dam Removal and Basin Restoration* (USBR 2012). The model results under the Proposed Project and No Project Alternatives provide adequate information to estimate the relative effects of the other alternatives not modeled.

USBR used KBRA flows as the hydrologic input for modeling floodplain inundation (USBR 2012). The 2013 BiOp changed the likely flow regime under which dam removal would occur in 2020 (i.e., no longer using KBRA flows). However, the differences in hydrology between KBRA and 2013 BiOp flows are minor (see Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* for further details regarding KBRA and 2013 BiOp flows).

The model results include predictions of the river flows that would occur if the four dams in the Lower Klamath Project were removed. The modeling effort provided useful information for assessing the impacts on flood hydrology in the long term but provides limited information about the construction period. Flood risks associated with dam removal activities are described qualitatively and quantitatively using the HEC-RAS and SRH-1D modeling results completed by USBR, and the analysis includes the measures incorporated to reduce these risks (USBR 2012).

The following sources were assessed to determine the scope of existing local plans and policies relevant to the Proposed Project:

- Del Norte County General Plan (Mintier & Associates et al. 2003):
    - Section 2 Safety and Noise
        - General Policies: 2.A.1, 2.A.2
        - Flood Hazards Policies: 2.D.1, 2.D.4, 2.D.6
        - Disaster Planning Policies: 2.G.1
- Humboldt County General Plan for Areas Outside of the Coastal Zone (Humboldt County 2017):
    - Chapter 14 Safety Element
        - General Policies: S-P1, S-P4
        - Flooding Policies: S-P12, S-P13, S-P14, S-P15

      - Flood Management Standards: S-S5, S-S6, S-S8
- Siskiyou County General Plan (Siskiyou County 1980)
  - Chapter 3 Land Use Policies
    - Flood Hazard Policies: 21, 22, 23, 24, 26
    - Surface Hydrology Policies: 27

Most of the aforementioned policies and standards are stated in generalized terms, consistent with their overall intent to address flood hydrology impacts. By focusing on the potential for impacts to specific flood hydrology issues within the flood hydrology Area of Analysis, consideration of the more general local policies listed above is inherently addressed by the specific, individual analyses presented in Section 3.6.5 *[Flood Hydrology] Potential Impacts and Mitigation;* and the more general local policies are not discussed further.

3.6.5 Potential Impacts and Mitigation

3.6.5.1 Flood Hydrology

Potential Impact 3.6-1 Reservoir drawdown and dam removal could result in short-term increases in downstream surface water flows and result in exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.

Reservoir drawdown activities would begin on November 1 of the year prior to drawdown at Copco No. 1 Dam, and on January 1 of the drawdown year at J.C. Boyle, Copco No. 1, and Iron Gate dams (see also Table 2.7-1 and Section 2.7.2 *Reservoir Drawdown*). The KRRC would control the releases that would vary by reservoir depending on the type of dam, discharge capacity, water year type, and the volume of water and sediment within the reservoir. The resultant reservoir water surface elevation after the initial drawdown would be generally higher in a wetter year than in a drier year at all the dams (see also Section 2.7.2 *Reservoir Drawdown*).

Reservoir drawdown in the Proposed Project includes considerations for minimizing potential flood risks. These considerations include carefully drawing down the Lower Klamath Project reservoirs using controlled flow releases (see Section 2.7.2 *Reservoir Drawdown*) and the increased storage availability in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs once drawdown has begun. If a flood event occurred during drawdown, the KRRC proposes to retain flood flows using the newly available storage capacity and continue drawdown after flood risks have ended. Existing conditions do not allow these reservoirs to assist in flood prevention in this manner.

At J.C. Boyle Dam, the KRRC would begin reservoir drawdown activities in January of the drawdown year (see also Table 2.7-1), while stream flows are still high. Controlled releases would initially be through the gated spillway and power intake, with drawdown increases to the existing river flow ranging from a minimum of 19 cfs (on average) to a maximum of 138 cfs (on average), assuming a continuous 5 feet per day drawdown (Appendix B: *Definite Plan*).

Because J.C. Boyle Reservoir has very little storage capacity, release flows would fluctuate throughout the drawdown period due to changes in reservoir inflow rate. Occasional periods of rapid increases in release flows would occur, with a total maximum drawdown release flow of approximately 3,000 cfs occurring for approximately 2-3 hours, then dropping back to near inflow values over a total of 6-8 hours (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., September 2018). The maximum capacity of the power intake is approximately 2,800 cfs. Therefore, flows above approximately 2,800 cfs would go over the spillway. Storm inflows large enough to cause refilling of the reservoir would also pass over the spillway. The reservoir drawdown is planned be completed by January 31 of the drawdown year, to minimize potential impacts at the downstream dam removal sites. The potential formation of reservoir ice in January at J.C. Boyle would not affect reservoir drawdown substantially during this period because reservoir releases at the dam would be maintained below ice cover (Appendix B: *Definite Plan*). Drawdown would proceed through the spillway and penstock, which would access the liquid portion of the reservoir. As the water level drops, surface ice would lower and start to crack. Broken ice on the reservoir surface would provide some amount of roughness that slows the flowing water in the canyon portion of the reservoir as well as reduces the entrainment of reservoir sediment. As a flowing condition is restored, surface ice would melt and be reduced because moving water mixes temperatures between the air and ground, the latter of which does not get cold enough in the Area of Analysis to freeze. The J.C. Boyle powerhouse successfully operates throughout the winter even with lake ice present (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., November 2018).

The additional controlled releases that would occur for the purposes of drawing down J.C. Boyle Reservoir would be unlikely to increase flood risks downstream of the California-Oregon state line because releases from the dam would be within the range of historical flows and so would not be a change from existing conditions. The 2-year and 5-year flow events downstream of J.C. Boyle Dam are 4,736 cfs and 7,719 cfs, respectively. A 10-year flow at J.C. Boyle results in an estimated flow of 10,362 cfs (see Table 3.6-11), and the maximum daily winter flow (January through March) is in excess of 8,000 cfs (USGS 2011). The average monthly flow below J.C. Boyle Dam for the period 1961−2009 was approximately 2,380 cfs in January, 2,450 cfs in February, and 2,890 cfs in March. Therefore, temporarily increasing the flow to approximately 3,000 cfs during reservoir drawdown would not result in exposing people or structures to substantial flood risks downstream of the California-Oregon state line.

Removal of the J.C. Boyle Dam embankment would occur in late June, July, and August of the drawdown year (see also Table 2.8-1) and would initially (June 15 to June 30) progress to no lower than elevation 3,778 feet amsl to provide sufficient elevation above a 150-year flood plus approximately 5 feet of freeboard. In July and August, the upstream cofferdam crest would not go below 3775 feet amsl to endure a 150-year flood plus approximately 5 feet of freeboard, and in September the cofferdam elevation would not go below 3771 feet amsl to endure a 100-year flood plus 0 feet of freeboard (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., September 2018). This drawdown scenario would involve flows up to approximately 3,500 cfs through the left abutment. The upstream cofferdam would be armored with rockfill to allow a controlled breach to fully drain the reservoir prior to September 30 of the drawdown year. Reservoir releases would temporarily exceed inflow by up to approximately 5,000 cfs, depending upon the rate of breach development, but would remain below the downstream channel capacity of 6,957 cfs (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., September 2018). Although the breach flow would quickly attenuate as it moved downstream due to the very small reservoir volume, the Iron Gate cofferdam would be breached before breaching the J.C. Boyle cofferdam as a precaution against the potential increased inflow to the Iron Gate impoundment (Appendix B: *Definite Plan*).

Although a limited drawdown (i.e., two feet per day) of Copco No. 1 Reservoir would begin on November 1 of the year prior to drawdown to allow early removal of the spillway gates and crest structure using a barge mounted crane, the primary drawdown and sediment release of Copco No. 1 Reservoir would begin January 15 of the drawdown year. Increased drawdown rates of five feet per day are delayed two weeks after drawdown releases begin at Iron Gate Dam (i.e., January 1) to create additional reservoir capacity at Iron Gate, which would better handle drawdown releases from Copco No. 1 Reservoir and help attenuate outflows from Iron Gate Reservoir due to storms. Drawdown would be limited to five feet per day to maintain reservoir rim slope stability and control drawdown releases from both reservoirs upstream of Iron Gate Reservoir. Maximum additional discharge downstream of Copco No. 1 Dam due to drawdown activities is anticipated to be about 6,000 cfs when the gate is opened on January 15. During other times the flow increase is generally 1,000 to 2,000 cfs. The total discharge capacity of the new gate structure with the reservoir at the spillway crest elevation of 2,597 feet amsl is about 12,000 cfs. If water levels increase above the spillway crest, the gate would be closed down to limit the total discharge to 13,000 cfs to avoid high water levels that would interfere with power production at Copco No. 2 Powerhouse. For reference, the 10-year, 20-year, 50-year, and 100-year flow events downstream of Copco No. 1 are 11,910 cfs, 13,543 cfs, 14,702 cfs, and 15,821 cfs, respectively. Storm inflows large enough to cause refilling of the reservoir would pass through the spillway.

Beginning January 15 of the drawdown year, as the Copco No. 1 Reservoir is drawn down through the new large gate structure at the downstream end of the diversion tunnel, penstocks, abutment gate houses, and above ground powerhouse equipment would be removed. After April 15 of the drawdown year Copco No. 1 Dam would be excavated in 12-foot lifts. Concrete rubble from the dam and powerhouse would be removed by truck. Temporary cofferdams in the river channel would be constructed as required for removal of the powerhouse and diversion tunnel control structures. The cofferdams would be removed once no longer needed and the upstream and downstream diversion tunnel portals would be plugged with concrete (Appendix B: *Definite Plan*).

Copco No. 2 Dam does not provide any meaningful storage, and the reservoir is very small compared to the other reservoirs, with little or no impounded sediment. Dam removal would begin on about May 1 of the drawdown year. No additional releases would be made from the upstream reservoirs during this time as they would have already been mostly drained. The KRRC would use cofferdams to isolate areas of the small concrete dam during demolition and would remove them once they were no longer needed (Appendix B: *Definite Plan*).

Reservoir drawdown at Iron Gate Reservoir would begin from normal operating elevation of 2,331.3 feet amsl on January 1 of the drawdown year by making controlled releases through the modified diversion tunnel. Reservoir drawdown would be limited to a maximum of five feet per day to maintain reservoir rim slope stability. Maximum additional discharge downstream of the dam due to drawdown activities would be approximately 4,000 cfs. Total discharge capacity of the modified diversion tunnel with the reservoir at spillway crest elevation of 2,331.3 feet amsl is about 10,000 cfs

(Appendix B: *Definite Plan*). For reference, the 10-year flow event downstream of Iron Gate Dam is 14,854 cfs.

Results from reservoir drawdown modeling (USBR 2012) indicate that during representative drier water years, Iron Gate Reservoir would be drawn down by early February of the drawdown year, and it would not refill after that point. During wetter water years the reservoir would be completely drawn down by March 1, but it could partially refill during storms later in the drawdown year. The majority of the accumulated sediment would mobilize during the initial drawdown, and subsequent reservoir filling and drawdown would be expected to cause only moderate increases in suspended sediment relative to background (USBR 2012). During the wettest water years, the reservoir would be completely drawn down by early March (Appendix B: *Definite Plan*).

Dam removal at Iron Gate Dam would begin following spring runoff on June 1 of the drawdown year and be completed by October 15. The removal plans require that sufficient freeboard be maintained to pass a 100-year flood at all times for those months between the elevation of the excavated embankment surface and any remaining reservoir water surface to reduce to potential for flood flows overtopping the embankment. During dam removal between June 1 and August 31, sufficient embankment elevation would be maintained to endure a 150-year flood event plus approximately 5 feet of freeboard. In September, the upstream cofferdam crest elevation would be maintained to endure a 100-year flood event plus 0 feet of freeboard (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., September 2018). September is the month that the cofferdam would be breached.

Dam excavation would proceed at an estimated 7,500 cubic yards (CY) per day in June, 14,250 CY per day in July, and 16,000 CY per day in August and early September, leaving an upstream cofferdam. Minimum reservoir flood release capacities would be approximately 7,700 cfs in June, 7,000 cfs in July, and 3,000 cfs in August and September, to accommodate the passage of at least a 100-year flood during those times of the year. By late September, the reservoir would be drawn down to the maximum possible extent, minimal streamflow would be occurring, and drawdown releases from upstream reservoirs would have ended. The upstream cofferdam would be armored with rockfill to allow a controlled breach. The cofferdam at Iron Gate Dam would be breached prior to breaching the cofferdam at J.C. Boyle Dam to minimize potential downstream impacts. The breach flow from J.C. Boyle Dam would quickly attenuate as it moved downstream due to the very small reservoir volume.

This analysis uses the reservoir drawdown release rates at Iron Gate Dam to determine the level of significance of adverse impacts downstream because Iron Gate Dam has the largest reservoir, provides the highest amount of discharge, and is the most downstream from all the dams that would be removed. The release rates that would occur during drawdown of the reservoir would be in the range of historical flows during an extremely wet year (one percent exceedance probability or 100-year flood event). While the release rates that would occur during reservoir drawdown would be greater than the flows at the same time under the existing conditions, and in some months above the historical monthly maximum flow (e.g., September), they would be lower than the overall peak flows for extremely wet years recorded during the period of record in each reach. Because the flows would stay below historical peak flows, they would not change the floodplain or flood risks in comparison to the existing conditions. Thus, the short-term increases in downstream flows and changes to flood risks resulting from reservoir drawdown would be less than significant.

Significance
No significant impact

Potential Impact 3.6-2 Under the Proposed Project recreational facilities currently located on the banks of the existing reservoirs would be removed following drawdown and could change flood hydrology.
The existing recreational facilities provide camping and boating access for recreational users of Copco No. 1 and Iron Gate reservoirs. Once the reservoirs are drawn down, most of these facilities would be removed (see also Section 3.20.4.3 *Reservoir-based Recreation*). These facilities would be well above the new river channel, and deconstruction would not place anything in the channel or otherwise impede low or high flows in the Klamath River. Therefore, there would be no impact to flood hydrology from the removal of recreational facilities.

Significance
No significant impact

3.6.5.2 River Floodplain

Potential Impact 3.6-3 The long-term FEMA100-year floodplain inundation extent downstream from Iron Gate Dam could change between river miles 193 and 174, potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.
Hydrologic and hydraulic modeling of floodplain inundation shows that removal of the Lower Klamath Project dams could alter the 100-year floodplain inundation area downstream of Iron Gate Dam between RM 193 and 174 (i.e., from Iron Gate Dam to Humbug Creek) (USBR 2012). The modeling indicates that the differences between existing conditions and the Proposed Project are minor. Floodplain inundation maps illustrating these model results are presented in Appendix K of this EIR. The mapping includes the effects of the increase in the 100-year flood peak flow rate and the small amounts of sediment deposition in the river channel following removal of the Lower Klamath Project dams.

Modeling of flood flows downstream of Iron Gate Dam indicates that the Lower Klamath Project dams provide a slight attenuation of peak flood flows. USBR (2012) estimated that the discharge of the 100-year peak flood immediately downstream of Iron Gate Dam would increase by up to seven percent following dam removal (Table 3.6-12) and flood peaks would occur about 10 hours earlier. This increased discharge would result in flood elevations that are 1.65 feet higher on average from Iron Gate Dam (RM 193) to Bogus Creek (RM 192.6) and 1.51 feet higher on average from Bogus Creek to Willow Creek (RM 188) (Appendix B: *Definite Plan*). The impact of dam removal on flood peak elevations would decrease with distance downstream of Iron Gate Dam, and USBR (2012) and the KRRC (Appendix B: *Definite Plan*) estimated that there would be no significant effect on flood elevations downstream of Humbug Creek (RM 174) because flow attenuation would occur in the mainstem channel and tributary peak flows would not coincide with the peak flow downstream of RM 193 (i.e., current location of Iron Gate Dam).

Table 3.6-12. Flood Attenuation of Iron Gate and Copco No. 1 Reservoirs on Flows at RM 193.

Flood Event	Peak Flow	Peak Flow - Proposed Project	Percent Reduction With Dams In
Synthetic 100-yr flood	31,460	33,800	6.9
1989	10,200	10,300	1.2
1993	11,100	11,400	2.7
1996	11,200	11,300	1.1
1997	20,500	21,400	4.0
2005	12,400	12,800	3.0

Source: USBR 2012

Changes in flood peak elevations and the extent of floodplain inundation under the Proposed Project could affect properties and structures along the river downstream of Iron Gate Dam during a flood event. The Klamath Basin is currently subject to flooding and FEMA has developed flood insurance risk maps that Siskiyou County has recognized in regulations concerning development along the river.

USBR (2012) estimated the number of residences and structures located along the Klamath River between Iron Gate Dam (RM 193) and Humbug Creek (RM 174) that would potentially be affected should the dams be removed. This estimate was based on photo interpretation and field visits. Structures along the Klamath River were categorized according to whether they are within the existing 100-year floodplain or would be in the altered 100-year floodplain following dam removal. The KRRC revisited the aerial photo analysis using the USBR (2012) floodplain boundaries and determined that a total of 34 legally-established habitable structures are located within the existing 100-year floodplain between Iron Gate Dam (RM 193) and Humbug Creek (RM 174), and an estimated 2 additional legally-established habitable structures would be within the altered 100-year floodplain in the same reach following dam removal, for a total of 36 legally established habitable structures within the altered 100-year floodplain following dam removal (Appendix B: *Definite Plan*). The KRRC defines legally established habitable structures as those that have running water, electricity, appliances, and sanitary service (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., September 2018). This includes residential and commercial structures that are intended for permanent habitation.

Although the original USBR hydrologic and hydraulic modeling was conducted assuming KBRA flows, it is reasonable to conclude that the likely adverse impacts to structures in the 100-year floodplain downstream of Iron Gate Dam and the timing of downstream flood peaks would be similar under the 2013 BiOp flow regime because: (1) the 2013 BiOp and KBRA flows are similar, and (2) there is no change to flood operations under the 2013 BiOp flows versus the KBRA flows (see also Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*).

An estimated three river crossings in this downstream reach could also be affected by the increase in flood depths: two pedestrian bridges and the Central Oregon and Pacific Railroad Bridge (Appendix B: *Definite Plan*). Both pedestrian bridges are below the existing 100-year flood elevation, and there is a potential increase in scour depth at the railroad bridge. Pedestrian Bridge #1 is dilapidated and is not structurally safe. Pedestrian Bridge #2 and the railroad bridge are in good condition. The KRRC proposes to remove Pedestrian Bridge #1, with the owner's permission. The KRRC proposes to consult with the owner of Pedestrian Bridge #2 during the detailed design phase to determine whether this bridge should be removed or replaced, at the KRRC's expense. The KRRC proposes to perform more analysis during the detailed design phase to confirm the effects of scour on the railroad bridge, as it may have sufficient footing and foundation depths to accommodate the increased scour potential but may need additional scour protection. The KRRC would make any needed improvements.

The change to the 100-year floodplain inundation area between Iron Gate Dam (RM 193) and Humbug Creek (RM 174) due to dam removal would result in exposing approximately two additional habitable structures to a substantial risk of damage due to flooding and is considered a significant impact. To address this potential impact, the Proposed Project includes implementation of the Downstream Flood Control Project Component (Project Component), as described in Section 2.7.8.4 *Downstream Flood Control* and in Appendix B: *Definite Plan*. This Project Component replaces Mitigation Measure H-2 from the 2012 KHSA EIS/EIR.

The KRRC proposes to work with willing landowners to implement a plan to address the significant flood risk for the 36 habitable structures (including permanent and temporary residences) located in the altered 100-year floodplain between Iron Gate Dam and Humbug Creek following dam removal. The KRRC would work with the owners to move or elevate the habitable structures in place before dam removal, where feasible, to reduce the risks of exposing people and/or structures to damage, loss, injury, or death due to flooding. However, flood damage and/or loss of structures that are not feasible to move or elevate would be a significant impact. Final determination of the future 100-year floodplain after dam removal would be made by FEMA. The KRRC is coordinating with FEMA to initiate the map revision process (Appendix B: *Definite Plan*). The Project Component would also evaluate the river crossings that could be affected by a substantial risk of damage due to flooding.

When a large flood event is predicted, the National Weather Service (NWS) River Forecast Center provides river stage forecasts and flood warnings for the Klamath River for the USGS gages at Seiad Valley, Orleans, and Klamath. The River Forecast Center is the Federal agency that provides official public warning of floods. They currently do not publish a forecast for river stage at the Iron Gate gage, however, they work with PacifiCorp to issue flood warnings to Siskiyou County.

Under the Proposed Project, the KRRC's Emergency Response Plan would include informing the NWS River Forecast Center of a planned major hydraulic change (i.e., removal of four dams) to the Klamath River that could potentially affect the timing and magnitude of flooding downstream of Iron Gate Dam (Appendix B: *Definite Plan*). The Emergency Response Plan replaces Mitigation Measure H-1 from the 2012 KHSA EIS/EIR. As needed, the River Forecast Center would update their hydrologic and hydraulic modeling of the Klamath River so that changes to the timing and magnitude of flood peaks would be included in their forecasts. The Proposed Project would not affect the River Forecast Center's practice of publicly posting flood forecasts and flood warnings for use by federal, state, county, tribal, and local agencies, as well as the public, so timely decisions regarding evacuation or emergency response can be made.

As described in the Definite Plan (Appendix B), the KRRC would also inform FEMA of the planned major hydraulic change to the Klamath River (i.e., dam removal) that could affect the 100-year floodplain. This would be done through a conditional letter of map revision (CLOMR) report, submitted to FEMA during the detailed design phase. Subsequently, the KRRC would submit a letter of map revision (LOMR) to FEMA to provide recent hydrologic and hydraulic modeling, and updates to the land elevation mapping so FEMA can update its 100-year floodplain maps downstream from Iron Gate Dam, as needed. These updates would provide critical information regarding real-estate disclosures, zoning decisions, and insurance requirements such that short- and long-term flood risks are evaluated and responded to by agencies, the private sector, and the public.

Overseeing development and implementation of the Downstream Flood Control Project Component and the Emergency Response Plan does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to work with willing landowners to implement a plan to address the significant flood risk and has initiated a process with FEMA to reach enforceable good citizen agreements that will be finalized and implemented, at this time these elements of the Proposed Project are not finalized, and the State Water Board cannot require their implementation. Accordingly, while the State Water Board anticipates that implementation of the Downstream Flood Control Project Component and the Emergency Response Plan, and any modifications developed through the FERC process that provide the same or better level of protection against flood damage, would reduce impacts to less than significant, because the State Water Board cannot ensure their implementation, it is analyzing the impact in this Draft EIR as significant and unavoidable.

Significance

Significant and unavoidable for exposing structures to a substantial risk of damage due to flooding

No significant impact related to exposing people and/or structures to a substantial risk of flooding related to flood forecasting

Potential Impact 3.6-4 The FEMA 100-year floodplain inundation extent downstream from J.C. Boyle Dam could change between the California-Oregon state line and Copco No. 1 Reservoir, potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.

As part of prior flood-inundation hydrologic and hydraulic modeling conducted for dam removal analyses, USBR (2012) ignored the potential effect of removing J.C. Boyle Dam on floodplain inundation downstream of the Hydroelectric Reach because this dam is approximately 35 miles upstream of Iron Gate Dam and is significantly smaller than either Iron Gate or Copco No. 1 dams. Within the Hydroelectric Reach, USBR (2012) did not conduct 100-yr floodplain mapping; however, FEMA (2016) mapping includes a 100-yr floodplain boundary for existing conditions on the Klamath River, including the Hydroelectric Reach (Appendix K).

Because J.C. Boyle Reservoir provides no storage and the dam typically operates in spill mode at flows above plant capacity (i.e., approximately 6,000 cfs; Table 2-1 in USBR 2012), existing conditions peak flows in the Hydroelectric Reach are not attenuated as a result of J.C. Boyle Dam. More specifically, the estimated spillway capacity of J.C. Boyle Dam at water surface elevation 3,793 feet amsl with all three gates open is 14,850 cfs

(USBR 2012), while the 100-yr estimated peak flow event in the Klamath River downstream of J.C. Boyle Power Plant is slightly lower, at 14,518 cfs (Table 3.6-11).

Therefore, under the Proposed Project the 100-yr flood inundation extent on the Klamath River from the Oregon-California state line downstream to Copco No. 1 Reservoir would not change from existing conditions (see also Appendix K).

Significance

No significant impact

Potential Impact 3.6-5 The release of sediment stored behind the Lower Klamath Project dams and resulting downstream sediment deposition under the Proposed Project could result in potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.

Depending on hydrologic conditions during drawdown and dam removal, approximately 90,000 to 170,000 U.S. tons of sediment behind J.C. Boyle Dam, 950,000 to 1,590,000 U.S. tons of sediment behind Copco No. 1 Dam, and 420,000 to 550,000 U.S. tons of sediment behind Iron Gate Dam would be eroded and flushed down the Klamath River during dam removal activities (USBR 2012) (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*). After dam removal, the remaining sediment would be left in place above the active channel. USBR conducted an analysis of future geomorphology and sediment transport during and after dam removal for dry, average, and wet start year scenarios. Most of the erosion would occur during the drawdown period from January 1 to March 15 of the drawdown year and afterwards the river bed in the reservoir reaches is expected to stabilize. Minor deposition would occur in some of the reaches downstream from dam removal activities, however none is expected downstream of the Shasta River confluence (USBR 2012). The Geology and Soils analysis considers the effects of sediment deposition in more detail (see Section 3.11.5 *[Soils, Geology, and Mineral Resources] Potential Impacts and Mitigation* of this EIR). Sedimentation would occur downstream from the Lower Klamath Project, but the quantity would vary depending on water year type. The magnitude of sediment deposition is relatively small compared to sediment loading from other existing sources along the Klamath River. The only measurable sedimentation would occur in the reach from Bogus Creek to Cottonwood Creek. In the short term (i.e., 2 years following dam removal), there is anticipated to be approximately 1.2 feet of deposition between Bogus Creek (RM 192.6) and Cottonwood Creek (RM 185.1) (Figure 3.11-12). This estimate is based on two successive median water years following dam removal. The predicted bed elevation changes under other modeled scenarios (i.e., two successive wet water year types and two successive dry water year types) are both less than the median water year scenario (USBR 2012). In the long term, average bed elevation is predicted to increase by approximately 1.5 feet in the reach from Bogus to Willow Creek and less than one foot downstream of Willow Creek. Additionally, the sedimentation is anticipated to occur primarily in pools and not in the riffle and bedrock sections that tend to control water surface elevations. Because the sediment deposition would be relatively small in comparison with the existing channel bed and bar sediment conditions, it would not affect stream characteristics in a way that would substantively alter flood inundation or flood risks and would therefore be a less than significant impact. Note that even though the effects of sediment deposition would be less than significant with respect to flooding risk, increases in bed elevations due to sedimentation were included in mapping the 100-year floodplain inundation areas downstream of Iron Gate Dam as described above.

Significance
No significant impact

3.6.5.3 Risks of Dam Failure

Potential Impact 3.6-6 Dam failure could flood areas downstream of the Lower Klamath Project.
Removing the Lower Klamath Project dams could reduce the risks of downstream flooding associated with a dam failure. The Lower Klamath Project dams store over 169,000 acre-feet of water that could inundate a portion of the watershed if the dams failed (Siskiyou County Web Site 2011). The dams are inspected regularly and the probability for failure has been found to be low. Removing the Lower Klamath Project dams would eliminate the potential for dam failure and subsequent flood damages and would therefore be beneficial.

The reservoir drawdown and dam removal processes are specifically designed to reduce the potential for dam failure during dam demolition that could result in downstream flooding. Dam embankment excavation at each site would not take place until after the reservoir was completely drawn down (Appendix B: *Definite Plan*). This approach precludes the possibility of dam demolition activities increasing the risk for failure and subsequent downstream flooding.

Copco No. 1 Dam is a concrete gravity arch structure that would require drilling and blasting during the dam removal phase (Appendix B: *Definite Plan*). Copco No. 1 Dam is thicker and wider at its base, which makes it very strong and less prone to risk of failure as the dam crest is lowered through demolition. With minimal water behind the dam due to reservoir drawdown, there would be little hydrostatic pressure against the remaining sections of the dam that could cause dam failure. Additionally, overtopping flows would not cause dam failure as is evidenced by the lack of deterioration to the stepped face on the downstream side of the dam. High flows have poured over the downstream side of the dam for over 100 years with no scour to the concrete. Seismic loading cannot be controlled by the Proposed Project, but as the dam is lowered, the strength of the remaining gravity structure increases, and therefore, the risk of seismic-induced failure would go down for a given event. Thus, there are no likely failure modes created by the removal process even if water did enter the drained reservoir during a late spring storm, and risk of a failure from the removal process is insignificant (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., November 2018). FERC requires a potential failure modes analysis, and the KRRC will be revisiting this topic in more detail prior to dam removal. FERC dam safety experts would have to approve the final dam removal analysis before a license surrender order could be issued.

See Potential Impact 3.6-1 for further discussion of reservoir drawdown and dam removal details.

Significance
Beneficial following dam removal

No significant impact during reservoir drawdown and dam removal

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3.7 Groundwater

This section describes the potential effects of the Proposed Project on groundwater levels, recharge, and availability. Potential effects of the Proposed Project related to water quality are described in Section 3.2 *Water Quality* and potential effects related to geology are described in Section 3.11 *Geology and Soils*.

Multiple comments were received during the NOP public scoping process relating to groundwater (Appendix A). These comments were primarily concerned with the potential effects of dam and reservoir removal on groundwater wells adjacent to the Lower Klamath Project reservoirs. Examples of specific concerns include the potential for groundwater levels to lower and/or well production to diminish. See Appendix A for further summary of the groundwater comments received during the NOP public scoping process, as well as the individual comments themselves.

3.7.1 Area of Analysis

The Area of Analysis for groundwater impacts includes the area within 2.5 miles of Copco No. 1, Copco No. 2, and Iron Gate reservoirs (Figure 3.7-1), which encompasses the area immediately adjacent to the reservoirs where the likelihood of groundwater well impacts due to the Proposed Project is greatest, as well as areas further from the reservoirs where regional groundwater flow data are generally available (Figure 3.7-2). The Area of Analysis lies within Siskiyou County, California and portions of Jackson and Klamath counties, Oregon. Portions of the Area of Analysis within Oregon are considered to the extent that they are likely to influence potential impacts to groundwater resources in California, rather than for potential impacts in Oregon.

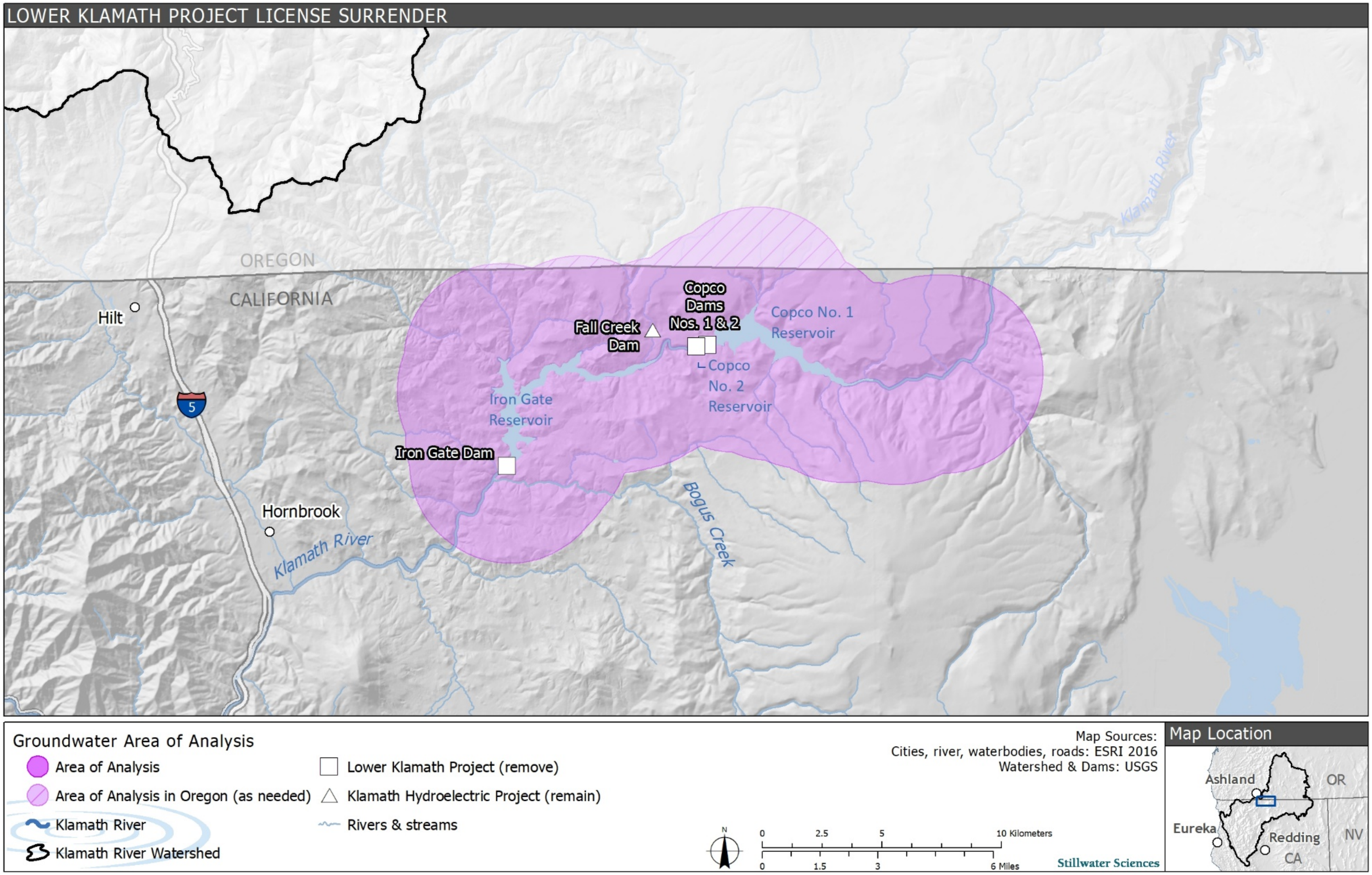

Figure 3.7-1. Groundwater Area of Analysis.

3.7.2 Environmental Setting

This section provides a description of the environmental setting for groundwater resources, including a brief overview of regional groundwater conditions and more specific groundwater information in the Area of Analysis.

3.7.2.1 Regional Groundwater Conditions

There are limited groundwater well data to support characterization of regional groundwater conditions in the Area of Analysis. Gannett et al. (2007) completed the most recent and comprehensive attempt to estimate the groundwater level gradients and flow patterns within the regional area upstream and downstream from each of the four Lower Klamath Project reservoirs. Figure 3.7-2 shows a generalized groundwater flow map for the Hydroelectric Reach of the Klamath Basin (i.e., from Iron Gate Reservoir to Upper Klamath Lake) and portions of the Lower Klamath Basin. Figure 3.7-2 suggests that the regional groundwater flow patterns along the Klamath River downstream from Keno Dam are generally from the higher elevations (upland areas, mountain ranges, hills, etc.) toward the Klamath River, and from Keno Dam toward Iron Gate Dam (USBR 2011). Figure 3.7-2 shows a very steep groundwater head gradient between Keno Dam and J.C. Boyle Reservoir. This steep head gradient suggests the presence of a groundwater barrier and is also roughly correlative with the mapped trace of the Sky Lakes fault zone (Personius et al. 2003). A groundwater barrier at this location implies that the groundwater system upstream of Keno Dam is separate from the groundwater system downstream of Keno Dam.

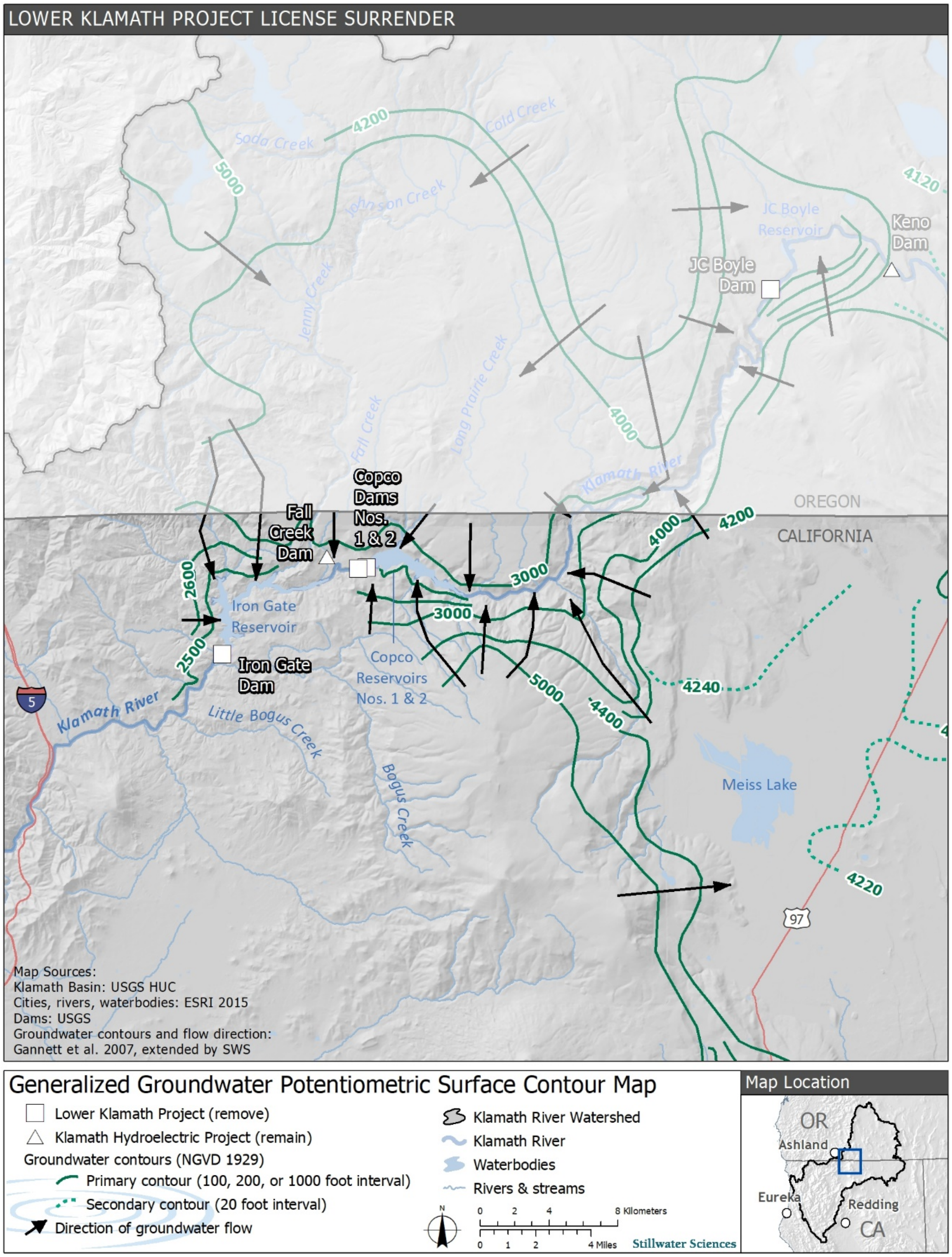

Figure 3.7-2. Regional Groundwater Map (modified from Gannett et al. 2007).

Closer to the Lower Klamath Project Reservoirs but still at the regional scale, USBR (2012) reviewed the area around the Iron Gate and Copco No. 1 reservoirs on USGS topographic 7½-minute quadrangle maps (Iron Gate and Copco No. 1 Quadrangles). Numerous springs, where groundwater discharges to the surface, occur in the area surrounding Iron Gate Reservoir. These springs occur at elevations from less than 50 feet to more than 300 feet above the reservoir level (USBR 2012). The maps also show springs around Copco No. 1 and Copco No. 2 reservoirs. These springs are similarly less than 50 feet to more than 800 feet above the reservoir levels (USBR 2012). The USGS maps also indicate a number of the small drainages that empty into Copco No. 1 Reservoir possess a spring at the headwater of the drainage, again at elevations hundreds of feet above reservoir surface water levels. The presence of numerous groundwater springs in the Area of Analysis indicates that regional conditions support a groundwater table that is near the ground surface, and also suggests that local groundwater systems are not likely to be receiving water directly from the reservoirs (USBR 2012). That is, at the regional scale, water discharging from groundwater springs in the Area of Analysis is not likely to be reservoir water (USBR 2012). Local groundwater conditions (i.e., immediately adjacent to the Lower Klamath Project reservoirs) are discussed in detail in Section 3.7.2.2 *Local Groundwater Conditions*.

Sources of Groundwater in the Area of Analysis

At the regional scale, groundwater in the Area of Analysis is likely fed by the infiltration of surface water and by precipitation and subsequent percolation through the sub-surface soil and bedrock units (Gannett et al. 2007). In the absence of barriers to vertical flow, surface water infiltration is a common source of recharge to groundwater systems. Rivers, lakes and other surface water bodies are common sources of site-specific infiltration recharge. Aerial precipitation is more of a dispersed source of infiltration recharge. As Figure 3.7-2 shows, at a regional scale, groundwater flows into the Area of Analysis from upland areas toward the Klamath River and the Lower Klamath Project reservoirs. Given a regional groundwater flow direction toward the river and reservoirs in the groundwater Area of Analysis (Figure 3.7-2), it is generally assumed that groundwater levels are supported by the regional groundwater system (USBR 2012).

At the local scale, wells immediately adjacent (potentially extending up to a mile from the reservoirs under certain conditions) to the reservoirs are more likely influenced by local site-specific variability in subsurface porosity and permeability. Where current groundwater levels in wells immediately adjacent to a reservoir are above the reservoir water surface elevation (e.g., at Iron Gate Reservoir), river and reservoir reaches are more likely to be receiving water from the regional groundwater system. In locations where current groundwater levels immediately adjacent to a reservoir are below the reservoir water surface elevation (e.g., at Copco No. 1 Reservoir), river and reservoir reaches may be receiving groundwater from the reservoir (USBR 2012). Given the existing data from local groundwater wells, these interpretations provide the best available conceptual characterization of regional and local groundwater resources in the Area of Analysis. Local groundwater conditions (i.e., immediately adjacent to the Lower Klamath Project reservoirs) in the Area of Analysis are discussed in more detail in Section 3.7.2.2 *Local Groundwater Conditions*.

Further upstream, a spring complex approximately one mile downstream of J.C. Boyle Dam contributes substantial flow to the Klamath River (Gannett et al. 2007). The water discharging at this site likely originates from the regional groundwater system, which, as described above, is generally near the ground surface. The flows could also be influenced by seepage from the reservoir that is flowing around or under J.C. Boyle Dam and coming to the surface at the spring site. It is likely that the flows from this spring complex are influenced by both the regional groundwater system as well as leakage from the reservoir (USBR 2012).

Groundwater Sinks in Area of Analysis

Features that cause a loss of groundwater from the groundwater system are called groundwater "sinks." In areas where surface water levels are lower than the adjacent groundwater level, groundwater can discharge to the surface water (e.g., rivers, streams, and reservoirs), making a groundwater sink. At a regional scale, Gannett et al. (2007) estimate that groundwater flow patterns move toward the Klamath River in the Area of Analysis (Figure 3.7-2). The USGS estimates an average groundwater discharge (sink) of 92 cfs for the reach from the J.C. Boyle Powerhouse downstream to Iron Gate Dam. Based on gage data and changes in reservoir storage, these estimates are calculated for the length of each of these reaches and may include some un-gaged tributary inflows.

Groundwater pumping is also a typical groundwater sink in the Area of Analysis. Domestic and limited irrigation are the primary uses of pumped groundwater in the Area of Analysis. Most domestic wells around the reservoirs are likely seasonal residences (i.e., owner's official address is different than the well location address) and are not expected to be a major groundwater sink in the Area of Analysis (USBR 2012). Average well yields in Siskiyou County, California are just over 19 gpm (USBR 2012). Based on completion dates on well logs for Siskiyou County, an average of five new wells per year have been installed in the Proposed Project area since 1963 (USBR 2012).

3.7.2.2 Local Groundwater Conditions

The California Department of Water Resources (DWR) *Bulletin 118 – Interim Update 2016, California's Groundwater,* delineates groundwater basins and sub-basins throughout the State. The Area of Analysis for the Proposed Project does not fall within one of these delineated basins. The area is defined as a "groundwater source area" by the DWR. A "groundwater source area" is defined as "rocks that are significant in terms of being a local groundwater source, but do not fit the [typical] category of basin or sub-basin" (DWR 2003). The Klamath River from the Oregon-California state line to downstream from Iron Gate Dam is a predominantly non-alluvial river flowing through mountainous terrain. Downstream from Iron Gate Dam, and for most of the river's length to the Pacific Ocean, the river maintains a relatively steep, high-energy, coarse-grained channel frequently confined by bedrock. Section 3.11.2.2 *Geomorphology* describes channel reach geomorphology for the Klamath River in the Area of Analysis and in downstream areas.

USBR (2012) obtained and reviewed groundwater well information from the California DWR and Oregon Water Resources Department (WRD) databases to identify well logs for known domestic and irrigation wells within several miles upstream and downstream from the Lower Klamath Project. Roughly 83 percent of the logs (300 out of 360 logs) included sufficient detail to locate the wells relative to the reservoirs. Of the 300 logs for which reasonable coordinate data could be determined, only 47 wells were within 2.5 miles of one or more of the three reservoirs within California, 25 near Iron Gate Reservoir and 22 near Copco No. 1 and Copco No. 2 reservoirs (USBR 2012).

Using the local topography, reservoir bathymetry, and lithologic descriptions on the well logs, representative cross-sections through the reservoirs and adjacent lands were drawn such that each cross-section intersected at least one known well location. Each cross-section displays the topography, water surface elevation of the reservoir, well log ID, abbreviated well log lithology, and the static water level in the well. Cross-sections aid in understanding the spatial relationship between surface waters, potential water-bearing lithologic units, and groundwater aquifers. The water-bearing units in each well are presented in summary tables for each reservoir (Tables 3.7-1 and 3.7-2).

Copco No. 1 and Copco No. 2 Reservoirs

As described in Section 3.11 *Geology and Soils*, Copco No. 1 and Copco No. 2 reservoirs are located at the contact between the Western Cascade Volcanics and the High Cascade Volcanics geologic provinces. The Western Cascade Volcanics is faulted and intruded by basaltic dikes. Its composition of stratified rocks with low to high permeability results in discrete aquifer units. Based upon the generally shallow depth of known groundwater wells, the groundwater near Copco No. 1 and Copco No. 2 reservoirs is likely from the permeable aquifer units of the High Cascade province or the upper water-bearing units of the Western Cascade province.

The California DWR well database identifies 22 wells within 2.5 miles of Copco No. 1 and Copco No. 2 reservoirs. Figure 3.7-3 shows the locations of the wells. The construction details for these wells are outlined in Appendix L. Five cross-sections that intersected at least one of the 22 wells were developed. Figure 3.7-3 shows the locations of these cross-sections. Figures 3.7-4 through 3.7-8 show the cross-sections and abbreviated descriptions are given in Table 3.7-1. The well parameters used to develop the cross-sections are summarized in Table 3.7-2.

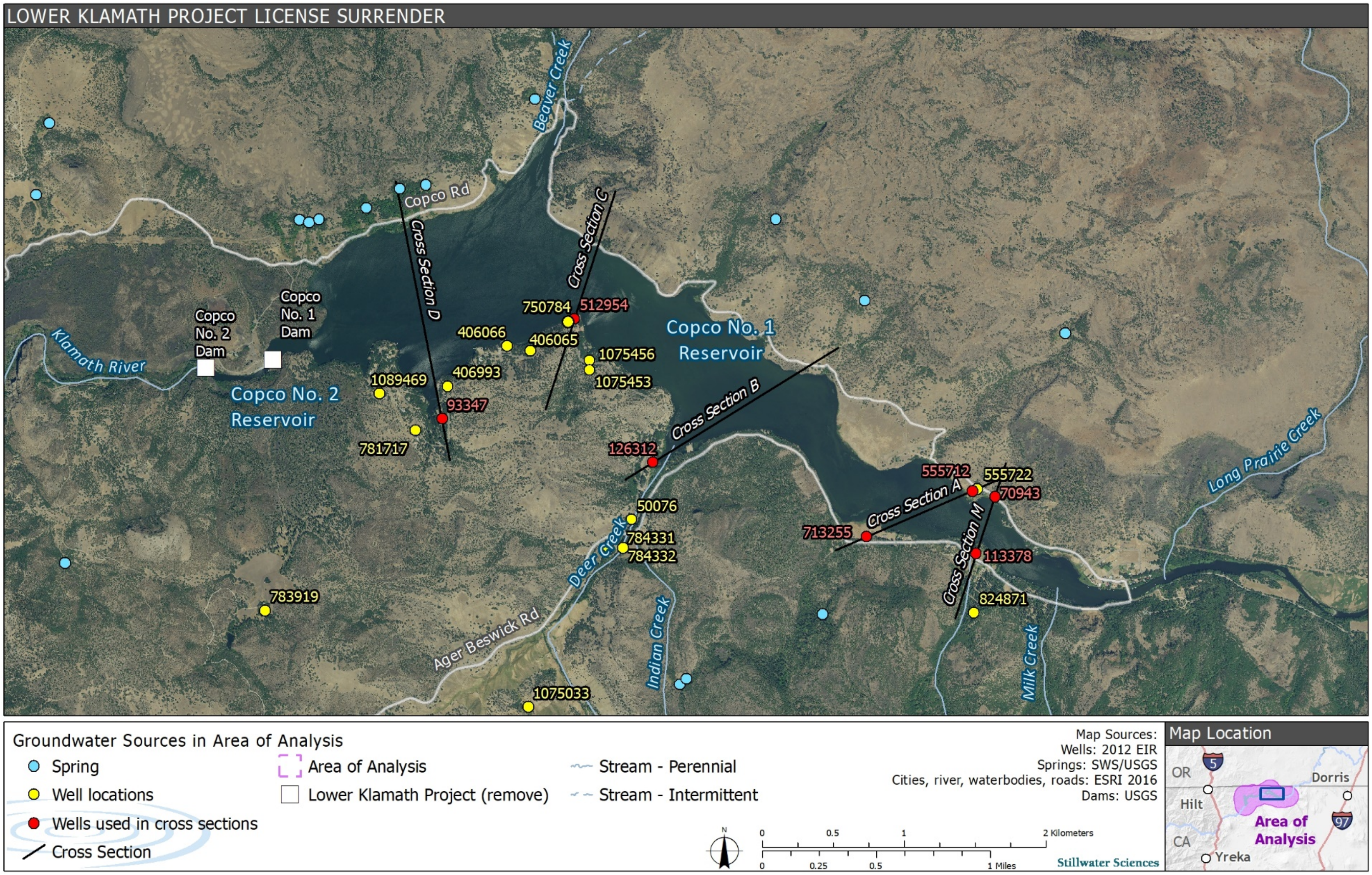

Figure 3.7-3. Locatable Wells within 2.5 Miles of Copco No. 1 and Copco No. 2 Reservoirs and Cross-section Locations. Adapted from USBR 2012.

Table 3.7-1. Abbreviations Used to Characterize Well Logs in Cross-sections.

Material	SDST	Sandstone
	CLST	Claystone
	BRNST	Brownstone
	GRST	Graystone
	SH	Shale
	CGLT	Conglomerate
	BDRK	Bedrock
	SPTN	Serpentine
	SLT	Silt
	MDST	Mudstone
Color	brn	Brown
	lt	Light
	grn	Green
	dk	Dark
	brnsh	Brownish
	grnsh	Greenish
	blk	Black
Other	decomp'd	Decomposed
	fract'd	Fractured
	interm't	Intermittent
	crs	Coarse
	am't	Amount
	med	Medium
	lgr	Large
	sm	Small
	comp'd	Compacted
	N/R	No recovery, no log, or illegible log

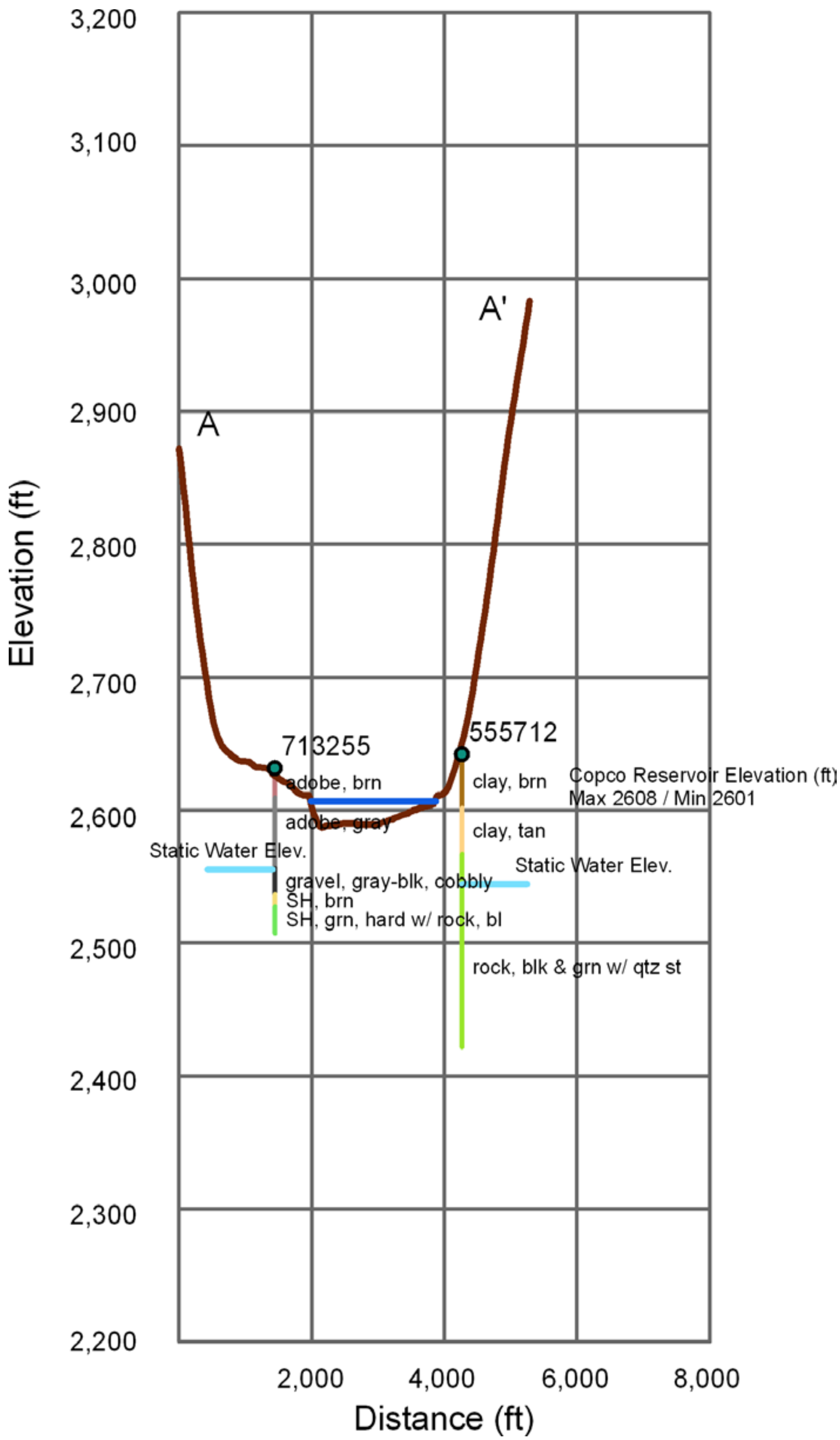

Figure 3.7-4. Copco No. 1 Reservoir, Cross-Section A-A' Depicting Groundwater Elevations and Stratigraphy Characterized in Wells. 20x vertical exaggeration. Dark blue line shows the elevation of Copco No. 1 Reservoir surface water and light blue line shows the static elevation of groundwater. Adapted from USBR 2012.

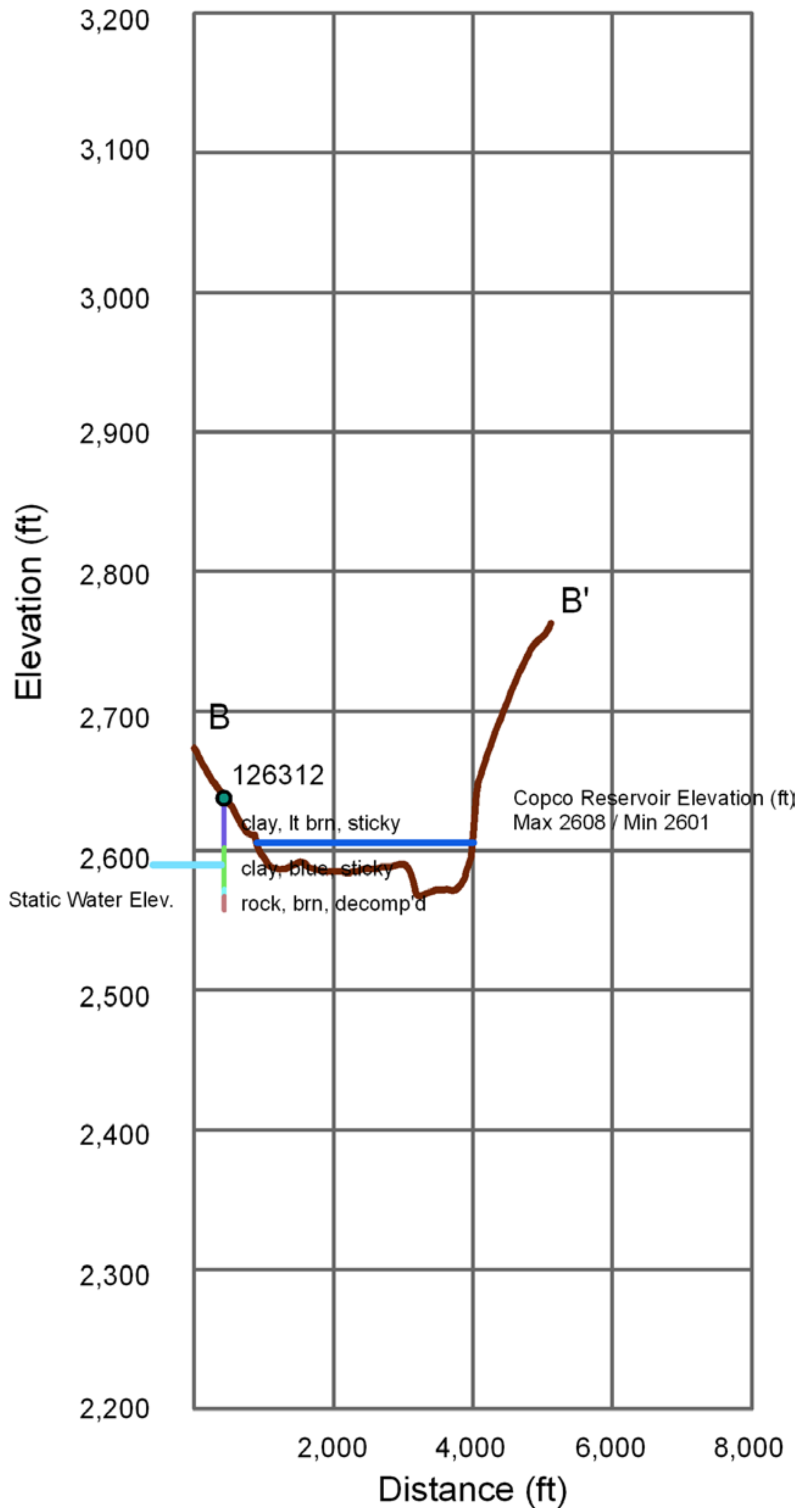

Figure 3.7-5. Copco No. 1 Reservoir, Cross-Section B-B' Depicting Groundwater Conditions and Stratigraphy Characterized in Wells. 20x vertical exaggeration. Dark blue line shows the elevation of Copco No. 1 Reservoir surface water and light blue line shows the static elevation of groundwater. Adapted from USBR 2012.

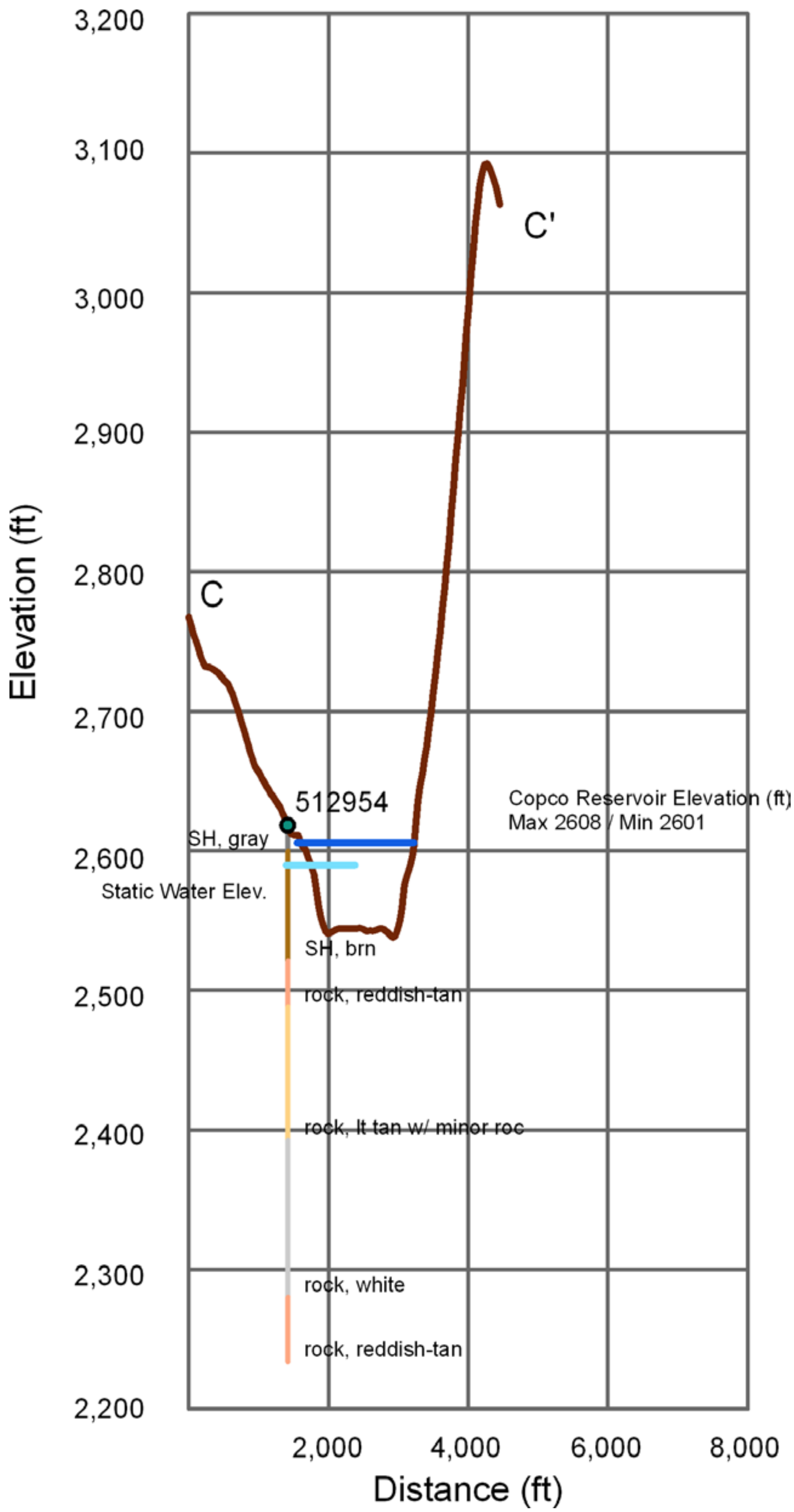

Figure 3.7-6. Copco No. 1 Reservoir, Cross-Section C-C' Depicting Groundwater Conditions and Stratigraphy Characterized in Wells. 20x vertical exaggeration. Dark blue line shows the elevation of Copco No. 1 Reservoir surface water and light blue line shows the static elevation of groundwater. Adapted from USBR 2012.

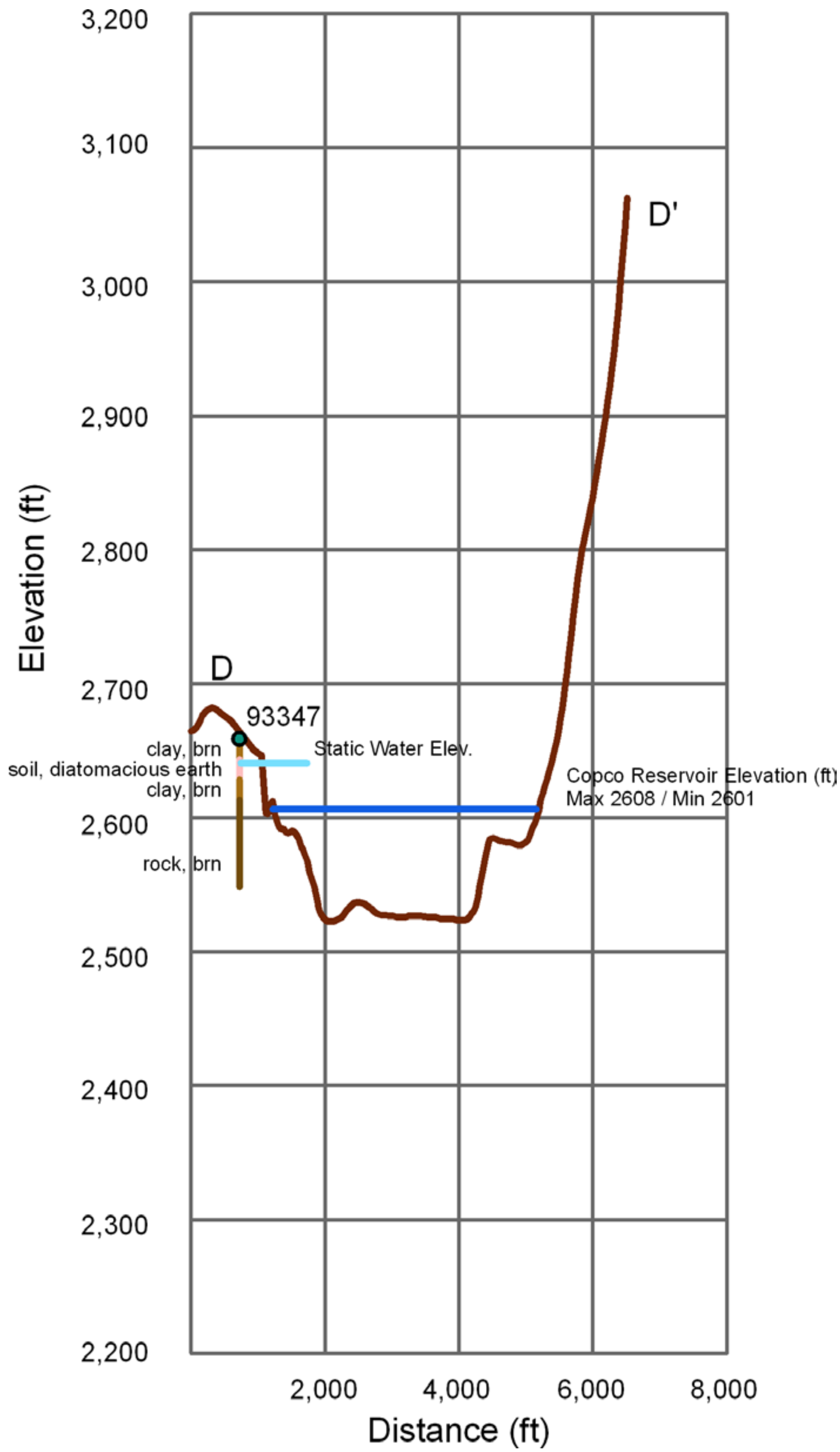

Figure 3.7-7. Copco No. 1 Reservoir, Cross-Section D-D' Depicting Groundwater Conditions and Stratigraphy Characterized in Wells. 20x vertical exaggeration. Dark blue line shows the elevation of Copco No. 1 Reservoir surface water and light blue line shows the static elevation of groundwater. Adapted from USBR 2012.

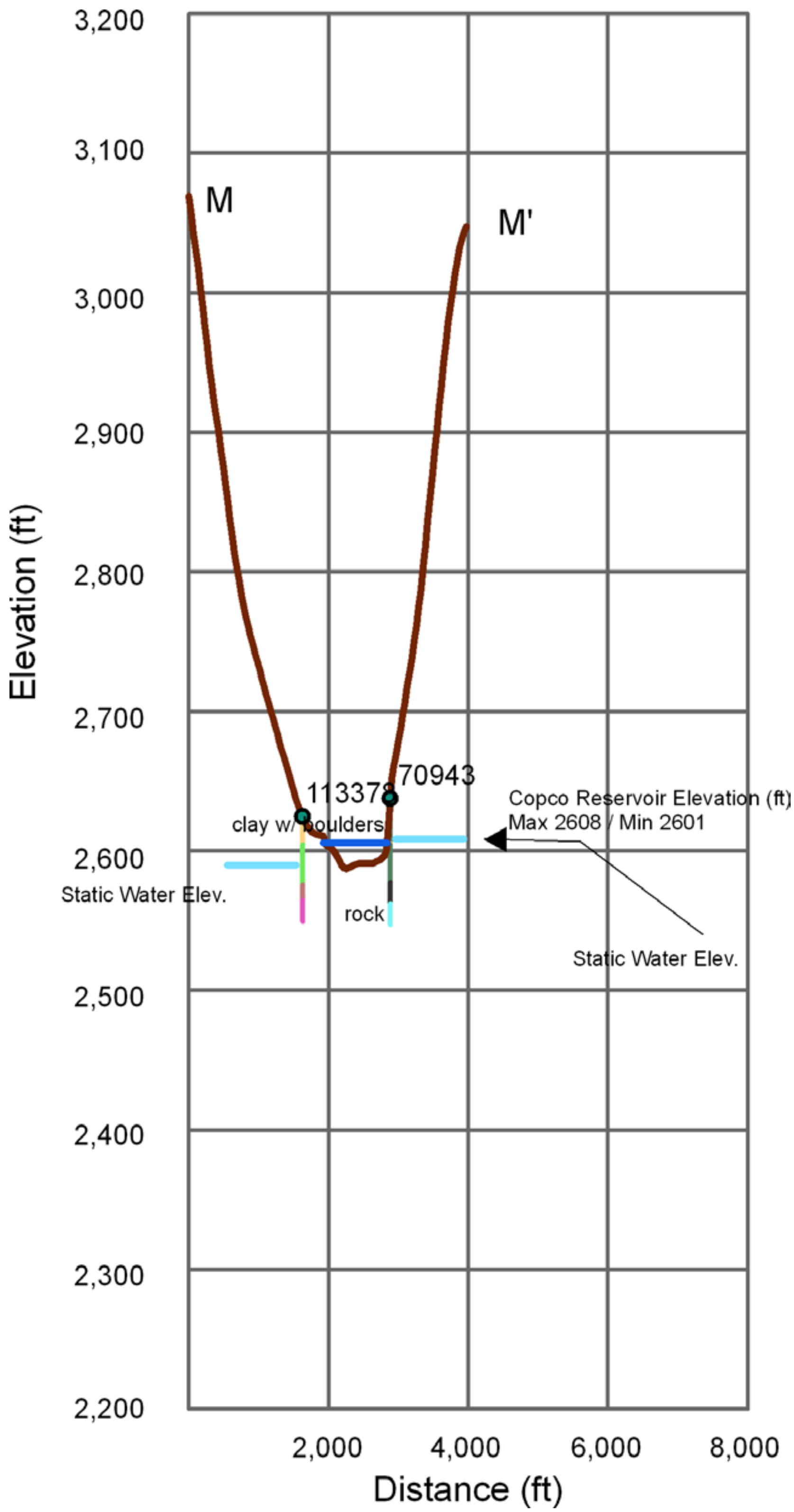

Figure 3.7-8. Copco No. 1 Reservoir, Cross-Section M-M' Depicting Groundwater Conditions and Stratigraphy Characterized in Wells. 20x vertical exaggeration. Dark blue line shows the elevation of Copco No. 1 Reservoir surface water and light blue line shows the static elevation of groundwater. Adapted from USBR 2012.

Table 3.7-2. Well Parameters for Copco No. 1 and Copco No. 2 Reservoir Wells used in Cross-sections A, B, C, D, and M.

Well ID[2]	Drill Date	Well Diameter (in)	Depth to Top of Perforated Zone or Bottom of Surface Casing in an Open Well (ft)	Depth to Bottom of Perforated Zone (ft)	Depth of Well (ft)	Depth to 1st Water (ft)	Pumping Rate (gpm)	Depth to Static Water (ft)	Located on Cross-section	Static Water Elevation (ft)	Water-Bearing Unit and Top Elevation (ft)
93347	8/5/1975	6	45 [3]	Open	110	N/R	20	15	D	N/R	Rock, 45- to 110-foot bgs; Elevation 2,608
126312	7/14/1976	6.625	63	83	83	55	10	40	B	2,597	Tight blue cemented sand, 55- to 70-foot bgs; Brown decomposed rock, 70- to 80-foot bgs; Elevation 2.582
512954	10/14/1998	6	75	225	384	N/R	2	50	C	2,566	Reddish tan rock, lighter tan rock, white rock, reddish tan rock; Elevation 2,541
555712	9/30/1994	6	100	120	220	N/R	15	80	A	2,597	Black/green rock w/quartz stringers, 100- to 120-foot bgs; Elevation 2,544
713255	7/19/1999	6	104 [3]	Open	124	N/R	30	60	A	2,565	Hard green and black rock, 104- to 124-foot bgs; Elevation 2,521
113378	08/01/1965	8	16	75	75	49	25	40	M	2,597	Small boulders, 49- to 60-foot bgs; Elevation 2,588
70943	06/20/1964	4.5	70	84	90	32	N/R	15	M	2,608	Gravel, 32- to 33-foot bgs; Elevation 2,591

Source: Adapted from USBR 2010 and USBR 2012.

Notes:

[1] Reservoir stage is 2,602 feet AMSL; river bed elevation at the dam is 2,493 feet AMSL.

[2] All wells listed as domestic supply wells.

[3] Depth to the bottom of the surface casing or sanitary seal in holes/wells that are open

Key:

AMSL: above mean sea level
bgs: below ground surface
in: inches
ft: feet
gpm: gallons per minute
N/R: Data not recorded

The data for the wells in the cross-sections indicate that the water-bearing units and static water levels are above the bottom of the reservoir. All except one of the wells near Copco No. 1 and Copco No. 2 reservoirs have static water levels that are below the reservoir stage but above the river bed elevation at the dam site. Similarly, all the wells except one have elevations for the top of the water-bearing unit below the reservoir stage and above the river bed elevation at the dam site. The two exceptions are two different wells. The top of the water-bearing unit was not identified on the log for some wells. In this case, the elevation at which water was first encountered in the drilling is used as a substitute for the top of the water-bearing unit.

The average static water level for all wells less than 300 feet from Copco No. 1 and 2 reservoirs is 2,591 feet while the average static water level for all wells more than 400 feet from the reservoir is 2,680 feet (USBR 2012). These levels suggest that there is inward groundwater flow near the reservoir (i.e., groundwater is flowing toward the reservoir). As groundwater is flowing toward the reservoir, water level in Copco No. 1 Reservoir is not expected to have a significant lateral influence on local groundwater levels (USBR 2012).

Iron Gate Reservoir

Like Copco No. 1 and Copco No. 2 reservoirs, Iron Gate Reservoir overlies units of the Western Cascade Volcanics geologic province, which has been faulted and intruded by basaltic dikes (Hammond 1983). Specific groundwater well data provides the best understanding of the occurrence of groundwater in the vicinity of Iron Gate Reservoir.

The identification of wells in the vicinity of Iron Gate Reservoir followed the same methods as for Copco No. 1 and Copco No. 2 reservoirs. The California DWR well database identifies 25 wells within 2.5 miles of Iron Gate Reservoir. Figures 3.7-9 and 3.7-10 show the locations of the wells. The construction details for these wells are outlined in Appendix L. Three cross-sections that intersected at least one of the 25 wells were developed. Figures 3.7-9 and 3.7-10 show the locations of these cross-sections. Figures 3.7-11 through 3.7-13 show the cross-sections. The well parameters used to develop the cross-sections are summarized in Table 3.7-3.

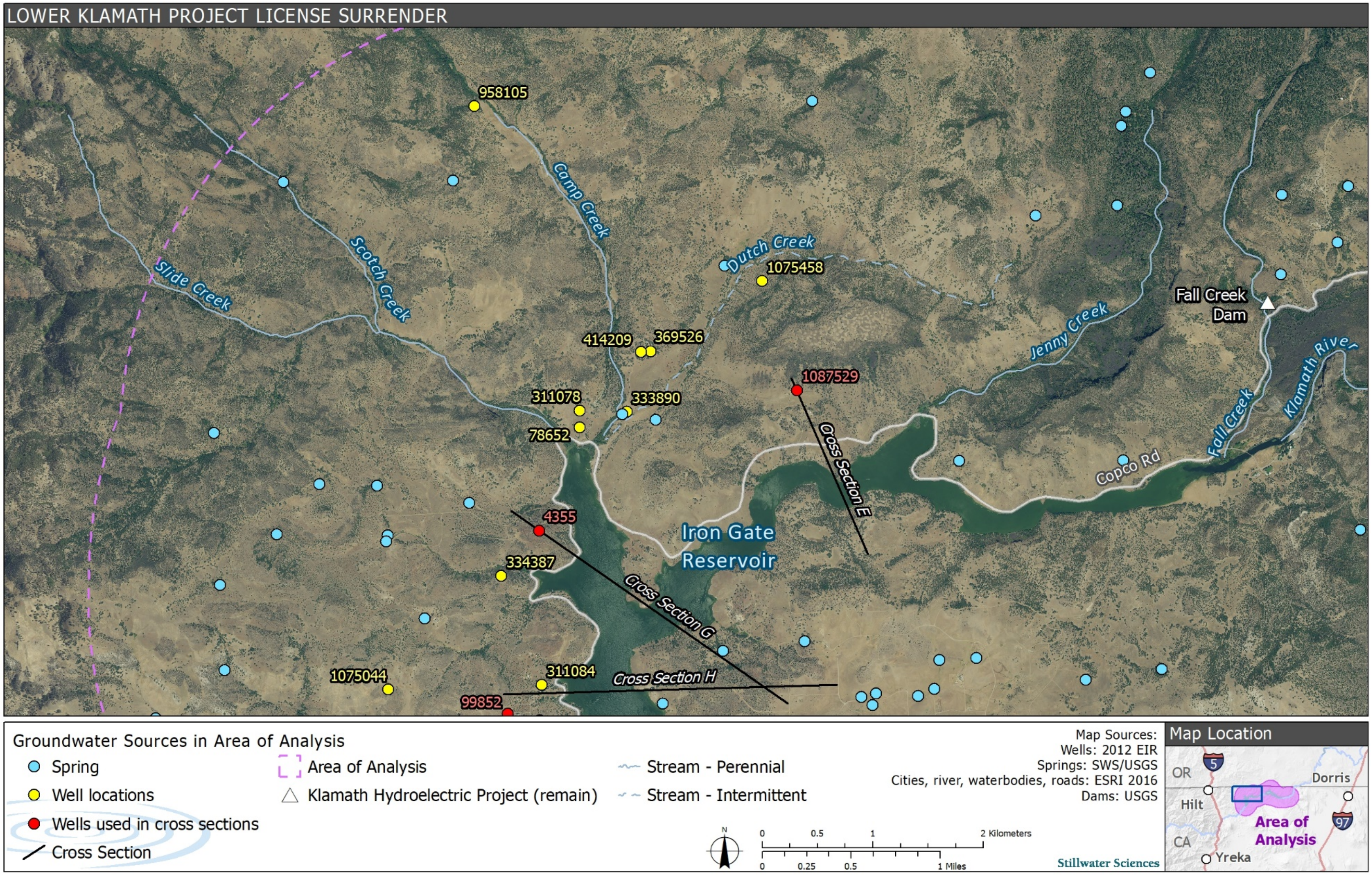

Figure 3.7-9. Locatable Wells within 2.5 Miles of Iron Gate Reservoir and Cross-section Locations. Adapted from USBR 2012.

Figure 3.7-10. Locatable Wells within 2.5 Miles of Iron Gate Reservoir and Cross-section Locations. Adapted from USBR 2012.

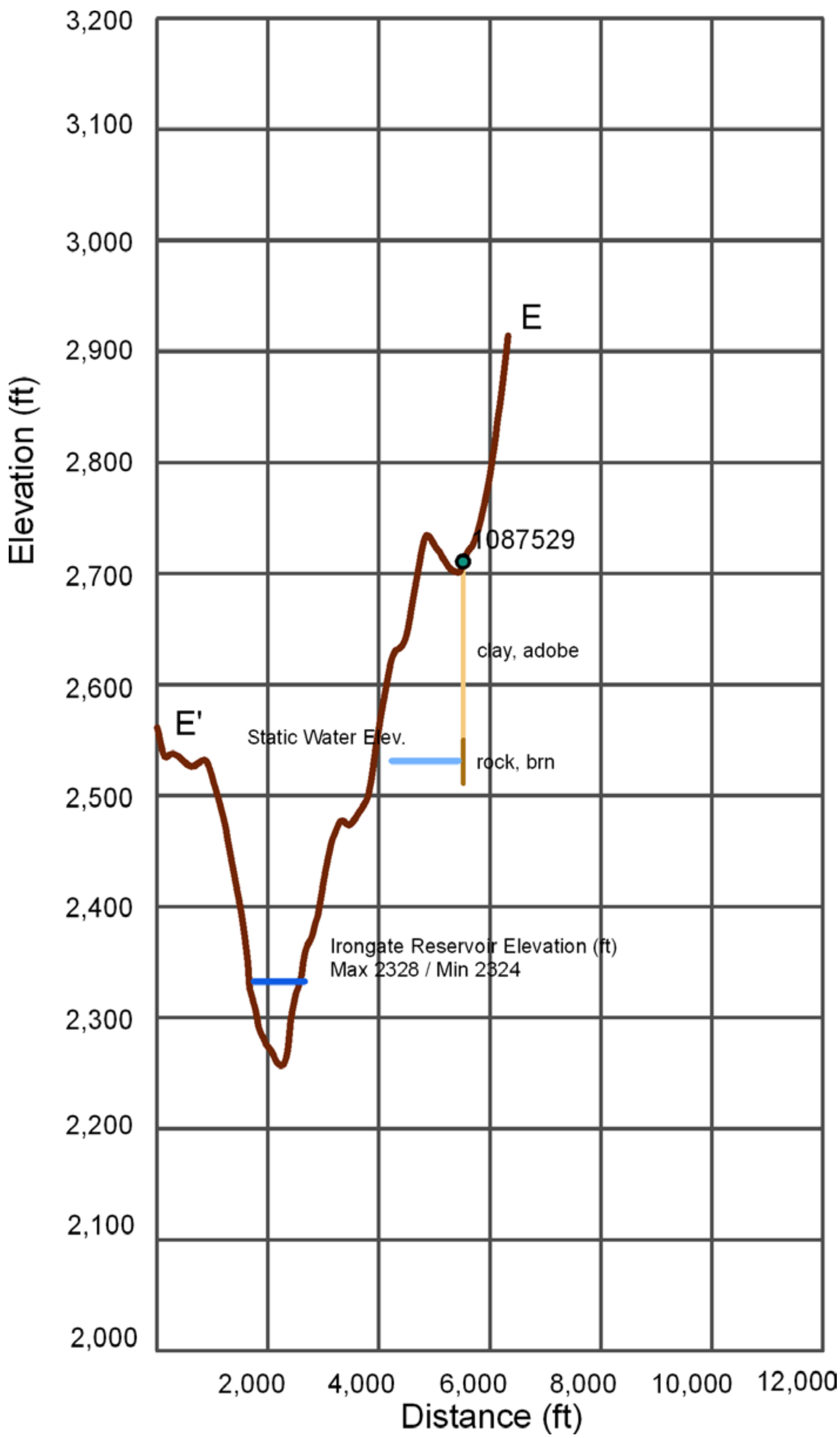

Figure 3.7-11. Iron Gate Reservoir, Cross-Section E-E' Depicting Groundwater Conditions and Stratigraphy Characterized in Wells. 20x vertical exaggeration. Dark blue line shows the elevation of Copco No. 1 Reservoir surface water and light blue line shows the static elevation of groundwater. Adapted from USBR 2012.

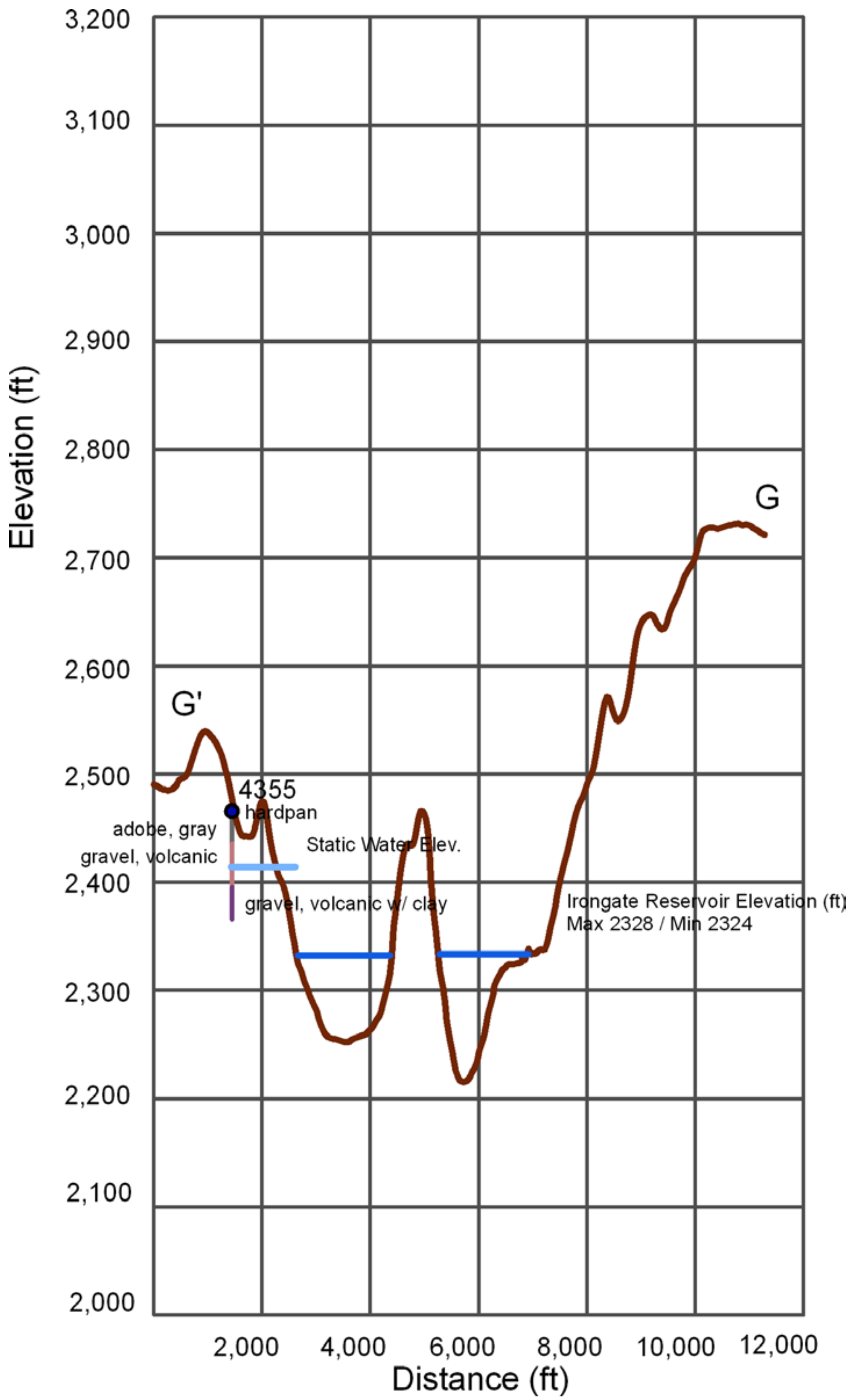

Figure 3.7-12. Iron Gate Reservoir, Cross-Section G-G' Depicting Groundwater Conditions and Stratigraphy Characterized in Wells. 20x vertical exaggeration. Dark blue line shows the elevation of Copco No. 1 Reservoir surface water and light blue line shows the static elevation of groundwater. Adapted from USBR 2012.

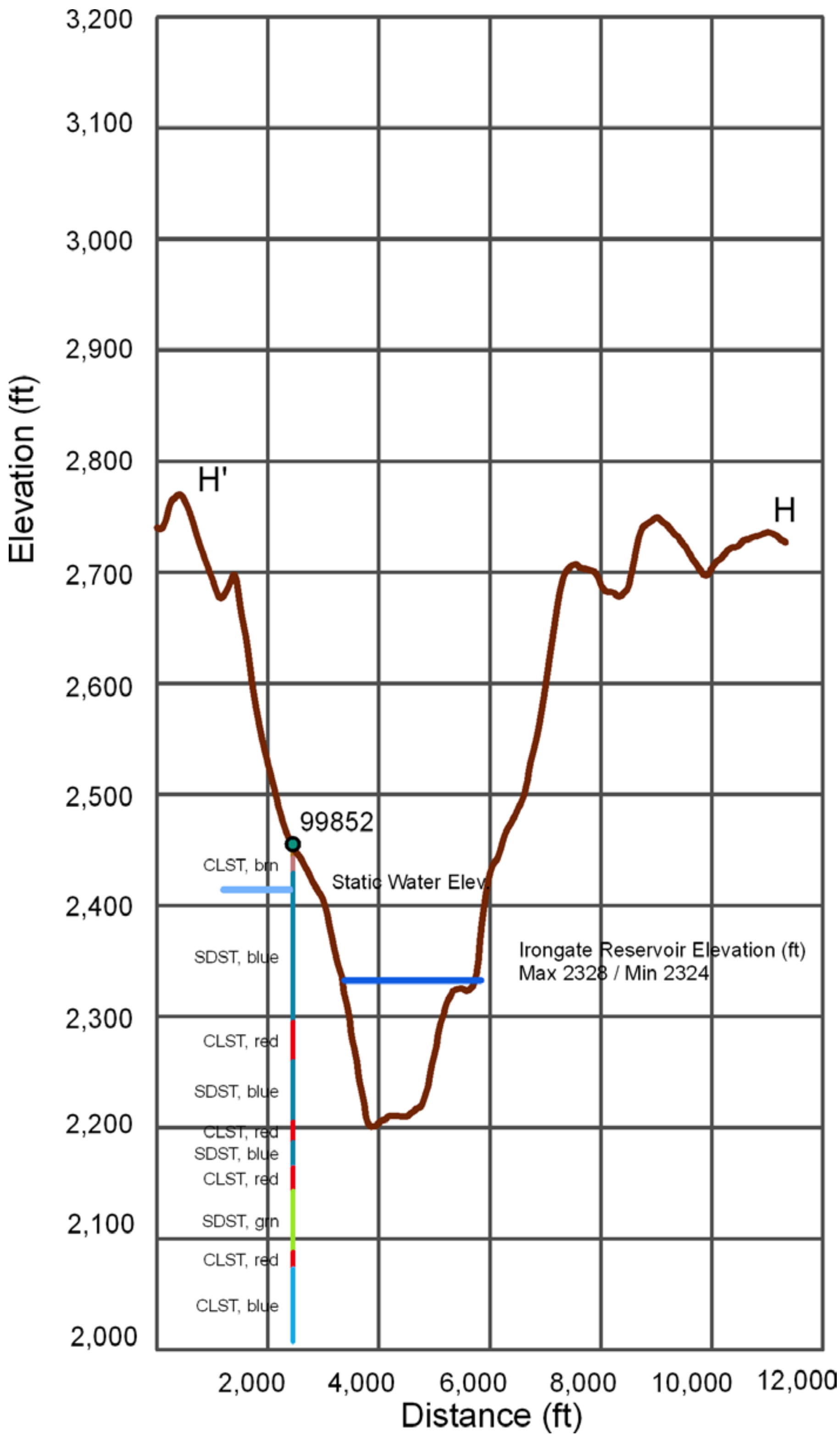

Figure 3.7-13. Iron Gate Reservoir, Cross-Section H-H' Depicting Groundwater Conditions and Stratigraphy Characterized in Wells. 20x vertical exaggeration. Dark blue line shows the elevation of Copco No. 1 Reservoir surface water and light blue line shows the static elevation of groundwater. Adapted from USBR 2012.

Table 3.7-3. Well Parameters for Iron Gate Reservoir[1] Wells used in Cross-sections E, G, and H.

Well ID[2]	Drill Date	Well Diameter (in)	Depth to Top of Perforated Zone or Bottom of Surface Casing in an Open Well[3] (ft)	Depth to Bottom of Perforated Zone (ft)	Depth of Well (ft)	Depth to 1st Water (ft)	Pumping Rate (gpm)	Depth to Static Water (ft)	Located on Cross-section	Static Water Elevation (ft)	Water-Bearing Unit and Top Elevation (ft)
4355	6/14/1966	8	12	70	100	30	10	50	G	2,424	Volcanic gravels, 30- to 700-foot bgs; Elevation 2,444
99852	9/1/1981	6.625	30	Open	500	191	5	150	H	2,563	Blue sandstone from 195- to 250-foot bgs; Elevation 2,518
1087529	5/1/2004	8	100	200	200	180	25	N/R	E	N/R	Brown rock, 160- to 200-foot bgs; Elevation 2, 532

Source: Adapted from USBR 2010 and USBR 2012.
Notes:
[1] Reservoir stage is 2,328 feet AMSL; river bed elevation at the dam is 2,165 feet AMSL.
[2] Wells 24272 and 29830 are domestic supply wells. Well 1087529 is listed as a domestic/irrigation well.
[3] Depth to the bottom of the surface casing or sanitary seal in holes/wells that are open
Key:
AMSL: above mean sea level
bgs: below ground surface
in: inches
ft: feet
gpm: gallons per minute

The well data show that the static water level (when recorded) is above the reservoir stage with only two exceptions (wells 781723 and 99834). The static water level for all but one of the wells (well 781723) is also above the elevation of the river bed at the dam site. The data in Appendix L show that the estimated elevation of the top of the water bearing unit (recorded on 13 of the 25 logs) is above the reservoir stage in 10 of the 13 wells. The top of the water-bearing unit is between the reservoir stage and the reservoir bottom in two wells. The top of the water-bearing unit is below the reservoir bottom in only one well (781723).

Wells further away from Iron Gate Reservoir have higher static water levels and generally higher top of water-bearing unit elevations than wells closer to the reservoir. These elevations indicate groundwater flow direction is toward the reservoir and is consistent with regional groundwater gradients (Figure 3.7-2). Wells within 2,000 feet of the reservoir have static water levels very close or above the reservoir stage (with one exception, well 334387) indicating a potential flow direction toward the reservoir. The current well dataset cannot determine conclusively whether Iron Gate Reservoir has any vertically downward or horizontal seepage (USBR 2012).

In summary, based on review of topographic and geologic maps, the Area of Analysis is underlain by permeable and porous rocks of the High Cascade and Western Cascade Provinces, and it contains abundant groundwater springs. Existing information indicates that while regional groundwater flow in the Area of Analysis is toward the Lower Klamath Project reservoirs, local (i.e., immediately adjacent to the reservoirs) groundwater levels exhibit site-specific variability, with the majority of wells exhibiting water levels above reservoir stage (i.e., groundwater flow toward the reservoir) and a small number of groundwater wells immediately adjacent to Copco No.1 Reservoir exhibiting water levels below the reservoir stage (i.e., potential groundwater flow from the reservoir toward the well).

3.7.3 Significance Criteria

Criteria for determining significant impacts on groundwater are based upon Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and professional judgment. Effects on groundwater are considered significant if the Proposed Project would result in:

- A substantial decrease of groundwater resources or substantial interference with groundwater recharge, lowering the local groundwater table level so that the production rate of existing nearby wells (i.e., within 2.5 miles of Copco No. 1, Copco No. 2, and Iron Gate reservoirs, see Section 3.7.1 *Area of Analysis*) would drop to an amount that would not support existing uses or planned uses for which permits have been granted.
- Substantially interfering with groundwater levels or groundwater recharge so there would be changes to groundwater/surface water interactions that would adversely affect surface water conditions or related resources.

This EIR does not analyze the potential for land subsidence due to groundwater aquifer collapse because the rock types in the Area of Analysis are not susceptible to collapse. Land subsidence caused by aquifer collapse can be caused by many processes such as the dewatering of fine grained materials (i.e., clays) or collapse of the structure of an aquifer (i.e., through over pumping, dissolution, or piping). The Area of Analysis does not contain areas underlain by extensive clay deposits, so it is not anticipated that the Proposed Project would cause land subsidence (Wagner and Saucedo 1987).

3.7.4 Impacts Analysis Approach

The groundwater impact analysis compares the potential effects of the Proposed Project to existing conditions. This analysis used the groundwater information presented in Section 3.7.2 *Environmental Setting* to evaluate potential effects on existing wells and on groundwater's influence on surface water resources in the Area of Analysis.

The analysis of potential or possible impacts to local wells from the Proposed Project is predicated on the conceptual model that in order to be impacted, the water-bearing unit that each well taps must be hydraulically connected to the reservoir—either by having the water-bearing stratigraphic unit exposed at the ground surface (i.e., daylight) within the reservoir walls or being hydraulically connected to the reservoir through a series of permeable layers between the reservoir and the water-bearing unit. Under the Proposed Project, removal of the Lower Klamath Project reservoirs has the potential to impact water levels in groundwater wells in the Area of Analysis. Other researchers have found that potential groundwater impacts to wells associated with dam removal are strongly controlled by local hydrogeologic characteristics and vary on a site-by-site basis (Berthelote 2013 and Tullos et al. 2016). Furthermore, peer-reviewed published literature addressing groundwater changes resulting from dam removal is extremely limited (Tullos et al. 2016). USBR (2012) concluded that based on local hydrogeologic conditions and well completion reports, potential impacts to groundwater wells in the Area of Analysis likely would only extend up to 0.5 mile from the Lower Klamath Project reservoirs.

The potential for impacts to the wells is further predicated on the relative elevation differences between the static water level in the well(s) and the water surface elevation of the reservoir. Specifically, if the water-bearing unit being tapped by any given well is hydraulically connected to a reservoir, then the static water level in the well should be similar or close to the water surface elevation in the reservoir. If the static water level is higher or lower than the reservoir level, and the water-bearing unit is not exposed along the reservoir walls, then it is likely that the water-bearing unit is reflecting a regional or local aquifer system influence in addition to, or in place of, the reservoir. If the water-bearing unit itself is entirely above the reservoir water levels, or it is substantially deeper (more than three or four intervening impermeable units) than the lowest portion of the reservoir, then it would be unlikely that the water-bearing unit would be in hydraulic connection with the reservoir. It should be noted that the static water level in a well can vary from year to year based on preceding hydrologic conditions (i.e., climatic cycles, wet years vs. dry years).

The following existing local plan is relevant to the Proposed Project:

- Siskiyou County General Plan (Siskiyou County 1980)
  - Chapter 3 Land Use Policies
    - Water Quality Policies: 17.

The aforementioned policy is stated in generalized terms, consistent with its overall intent to protect groundwater resources. By focusing on the potential for impacts to specific groundwater resources within the groundwater Area of Analysis, consideration of the more general local policy listed above is inherently addressed by the specific, individual analyses presented in Section 3.7.5 *[Groundwater] Potential Impacts and Mitigation*, below.

3.7.5 Potential Impacts and Mitigation

Potential Impact 3.7-1 Groundwater levels in existing wells adjacent to the reservoirs could decline in response to the decrease in reservoir surface-water elevations if the dams, and therefore reservoirs, are removed.

The water-bearing units from which most of the existing domestic and/or irrigation wells pump have one of three relationships to the hydroelectric reach: (a) below the elevation of the original river channel, (b) exposed along reservoir walls, or (c) above the reservoir stage. This analysis provides the reasonable inferences regarding the hydraulic connection between these water-bearing units and the reservoirs, as the paucity of measured data precludes more detailed analysis.

The location, underlying hydrogeologic conditions (i.e., how groundwater moves through underlying sediment and rock), and construction characteristics for a groundwater well can influence the potential impact of reservoir removal on well water levels. Some of the water-bearing units tapped by existing domestic and/or irrigation wells (approximately 27 of the 47 wells within the Area of Analysis) lie above the reservoir water surface elevations and are at elevations similar to those of mapped springs. These springs are likely fed by the same water-bearing units supplying the wells and therefore water levels in the wells are not expected to be significantly impacted by the removal of the reservoirs. Domestic and irrigation wells that pump from water-bearing units that are directly connected to the reservoirs (approximately 13 wells) would likely be affected by reservoir removal and the impacts could be significant. Wells that tap water-bearing units below the bottom of the reservoir (approximately 6 wells) are assumed to be maintained by regional groundwater flow patterns that would continue to “sink” toward the restored Klamath River and its alluvial floodplain. Consequently, those wells are unlikely to be affected by the removal of the reservoirs. Ultimately, however, the potential impacts at specific wells would also depend upon local hydrogeologic conditions at the well site location and the well construction characteristics.

Because of limited existing well location data, there could be additional domestic or irrigation wells in water-bearing units that intercept the reservoirs. There are existing domestic and irrigation groundwater wells that could not be reliably located based on the information in the Oregon WRD or California DWR water well databases. In addition to the non-locatable wells in the databases, real estate information suggests the potential for some additional wells. The real estate information presented in the Dam Removal Real Estate Evaluation Report prepared by the DOI in 2011 lists 1,467 potentially impacted parcels near the Copco No. 1, Copco No. 2, and Iron Gate reservoirs. Of those 1,467 parcels, 12 percent (176 parcels) are listed as improved and 88 percent (1,291 parcels) are shown as vacant (Bender Rosenthal, Inc. 2011). The extent of improvements on the 12 percent of parcels is not known. However, it is possible that improvements may have included installation of a groundwater well for domestic and/or irrigation supplies.

In light of the likely connectivity of some wells’ water source with the reservoir, and in light of data gaps, it is possible that removal of the reservoir would cause a substantial decrease of groundwater levels and a corresponding decrease in production rates in existing wells to a degree that interferes with existing or planned uses. This would be a significant impact.

However, the Proposed Project includes implementation of the Groundwater Well Management Plan, as described in Section 2.7.8.7 *Groundwater Well Management Plan* and in Appendix B: *Definite Plan*. The Groundwater Well Management Plan is intended to identify groundwater wells that may be adversely impacted following dam removal and reservoir drawdown and provide sufficient monitoring to understand the effects, if any, on groundwater levels and quality. The Well Management Plan would further identify short and long-term measures to address and mitigate any supply impairments encountered.

Under the Groundwater Well Management Plan, baseline conditions would be determined by monitoring sentinel wells within 2.5 miles of the reservoirs, and ideally within 0.25 miles of the reservoirs. Sentinel wells would include those belonging to volunteer landowners, or if an insufficient number of well owners volunteer to participate in the groundwater monitoring activity, a minimum of ten wells around the three reservoirs on PacifiCorp's Parcel B lands (tentatively, up to four monitoring wells each at Iron Gate and Copco No. 1 reservoirs, and two wells at J.C. Boyle Reservoir). Sentinel wells belonging to participating landowners and any monitoring wells installed by the KRRC would be monitored pre-, during, and post-dam removal to identify seasonal fluctuations in groundwater levels and any groundwater level changes resulting from reservoir removal. Sentinel wells would also be monitored for general water quality parameters including pH, conductivity, and major anions and cations. The KRRC would monitor sentinel wells monthly for a minimum of one year prior to dam removal and monthly for up to one year following dam removal, or until such time that groundwater levels and general water quality parameters have stabilized (no discernable water level declines or changes in quality over a four-month period) or they mirror baseline conditions (Appendix B: *Definite Plan*).

Under the Groundwater Well Management Plan, if groundwater levels in existing wells adjacent to the Lower Klamath Project reservoirs are found to be substantially depleted following dam removal, such that production rates drop to levels that do not support designated domestic or irrigation uses, the KRRC would undertake measures to return the production rates of the affected domestic or irrigation groundwater supply wells to conditions existing prior to dam removal. Short-term measures would include actions providing temporary water supplies until long-term measures such as motor replacement, well deepening, or full well replacement are identified and implemented. The regional and local groundwater pattern of groundwater flow toward the Lower Klamath Project reservoirs suggests that the measures in the Groundwater Well Management Plan would be successful in completely mitigating the identified potential impacts. Because successful implementation of the proposed short-term and long-term measures would return production rates of any affected domestic or irrigation groundwater supply wells to conditions existing prior to dam removal, there would be no significant impact on groundwater levels in existing wells adjacent to the reservoirs.

The State Water Board has issued a draft water quality certification[136] which sets forth monitoring and reporting requirements for groundwater wells surrounding the Lower Klamath Project reservoirs as part of Condition 14.

Significance

No significant impact

Potential Impact 3.7-2 The Proposed Project could interfere with groundwater recharge and adversely affect surface water conditions in the Klamath River.

Because of the underlying geology, removal of the Lower Klamath Project reservoirs is not expected to interfere with groundwater recharge that could potentially affect surface water flows in the Klamath River. Sometimes, removing reservoirs from an area can result in percolation of less surface water to the underlying groundwater aquifers. However, as discussed in Section 3.7.2 *Environmental Setting* the reservoirs generally lie within rock valleys where groundwater recharge is expected to be low. Gannett et al. (2007) concluded that the Klamath River reaches in the Area of Analysis are gaining reaches (i.e., groundwater discharges to the stream). This assessment and the characteristics of the rock surrounding the reservoirs suggest that any surface water that may have infiltrated to groundwater aquifers under the reservoirs would likely discharge back to the river just downstream from the impoundments, rather than increasing aquifer storage. Therefore, there would be a less than significant impact on groundwater recharge and the resulting groundwater/surface water interactions due to the Proposed Project.

Significance

No significant impact

3.7.6 References

Bender Rosenthal, Inc. 2011. Dam Removal Real Estate Evaluation Report for U.S. Department of the Interior, Bureau of Land Management and Bureau of Reclamation, March 22, 2011. Available at: https://klamathrestoration.gov/sites/klamathrestoration.gov/files/Real%20Estate%20Evaluation%20Report_final.pdf

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Gannett, M. W., K. E. Lite, Jr., J. L. La Marche, B. J. Fisher, and D. J. Polette. 2007. Ground-water hydrology of the Upper Klamath Basin, Oregon and California. U.S. Geological Survey Scientific Investigations Report 2007-5050. Version 1.1. Available at: http://pubs.usgs.gov/sir/2007/5050/. April 2010 revision.

[136] The State Water Board's draft water quality certification is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 19, 2018).

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3.8 Water Supply/Water Rights

This section describes the potential effects of the Proposed Project on surface water supply availability for existing water rights.

The potential for water supply impacts is an important concern for local residents in the area of the reservoirs and downstream in the Mid and Lower Klamath basins. Multiple comments were received during the NOP public scoping process relating to water supply and water rights (Appendix A). These comments were primarily concerned with the potential effects of dam and reservoir removal on water supply for water right holders. Specific concerns included: (1) reductions in water supplies for Klamath River diverters; (2) indirect impacts to water users on Klamath River tributaries, through potential higher bypass requirements to meet environmental needs; and (3) adverse impacts to water diversion infrastructure, including wells, downstream diversion facilities, and the City of Yreka's municipal water supply pipeline. See Appendix A for further summary of the water supply and water rights comments received during the NOP public scoping process, as well as the individual comments themselves. Potential impacts to private groundwater wells are addressed in Section 3.7 *Groundwater*.

3.8.1 Area of Analysis

The Area of Analysis for water supply/water rights includes portions of the Upper, Middle, and Lower Klamath River from the California-Oregon border downstream to the river's mouth (Figure 3.8-1). The portion of the Upper Klamath River included in the Area of Analysis is along the Hydroelectric Reach and extends from the California-Oregon border to Iron Gate Dam. The Middle Klamath River extends from Iron Gate Dam downstream to the Trinity River confluence and the Lower Klamath River extends from the Trinity River downstream to the Klamath River's mouth. The Area of Analysis also includes portions of the Upper Klamath Basin located within California that receive water deliveries from the Klamath Irrigation Project (e.g., Tule Lake and Lower Klamath Lake).

Fall Creek is included in the Area of Analysis because the Proposed Project involves restarting hatchery operations there, and has the potential to impact the City of Yreka's Fall Creek diversions for municipal water supply. However, except for Fall Creek, the Area of Analysis does not include water rights on tributary rivers because water supply availability in these rivers is not affected by ceasing the non-consumptive hydroelectric power use under the Proposed Project, or by the Proposed Project's discharges.

Residents in the Scott and Shasta river basins raised concerns that removal of the hydroelectric facilities would reduce the water supply available for environmental purposes in the Klamath River mainstem, and that as a result, water diverters in tributaries to the Klamath will be curtailed to increase mainstem surface water flows. Please see Potential Impact 3.8-2 for a discussion of the limited use of hydroelectric project water to assist the USBR in meeting environmental flow obligations. Because the USBR maintains its biological opinion obligations regardless of the existence of the Lower Klamath Project, dam removal would not alter the amount of water available for environmental purposes, or the source of that water. Thus, there would be no water availability impact to tributaries to the mainstem Klamath River from implementation of the Proposed Project.

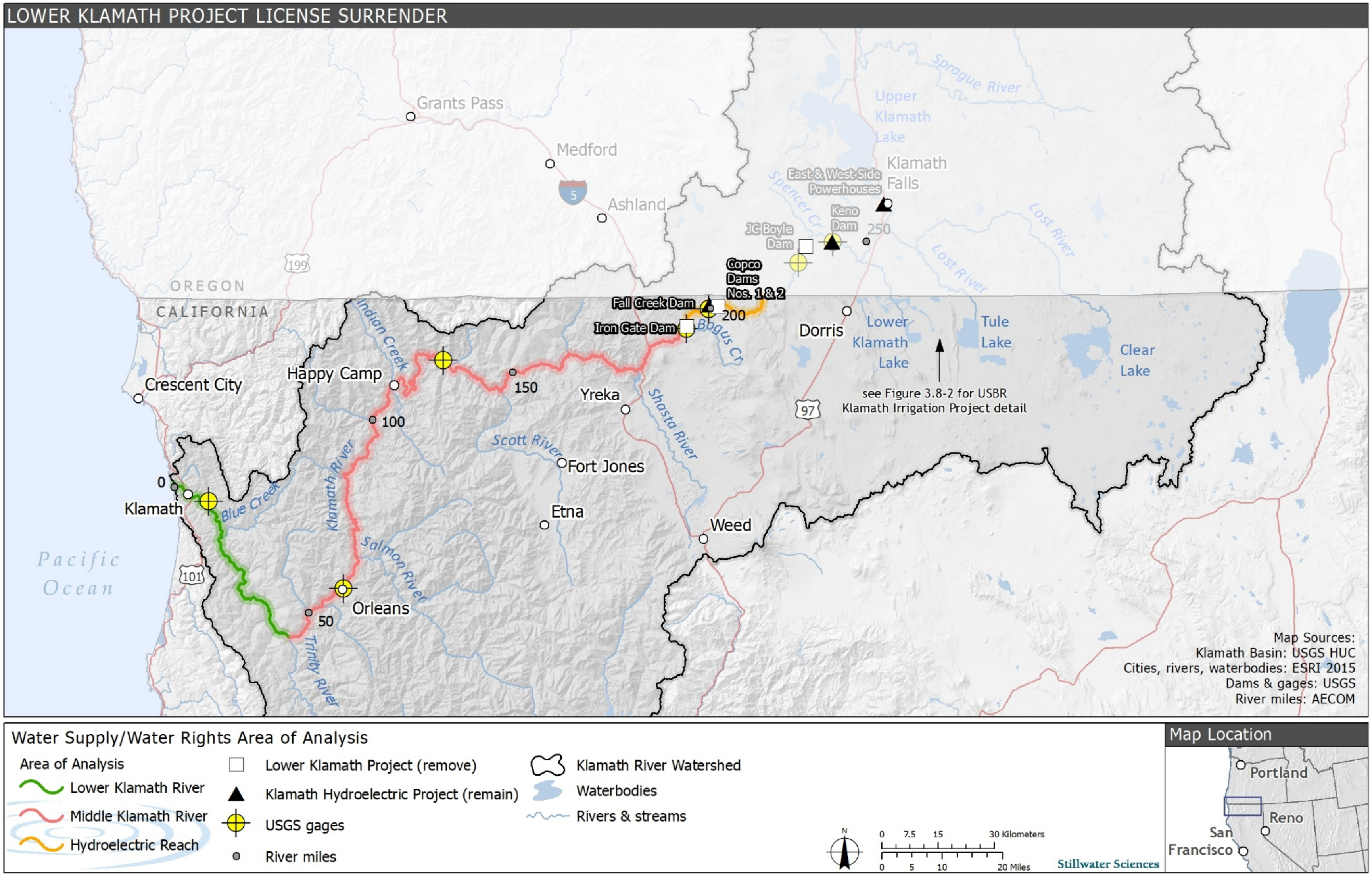

Figure 3.8-1. Water Supply/Water Rights Area of Analysis.

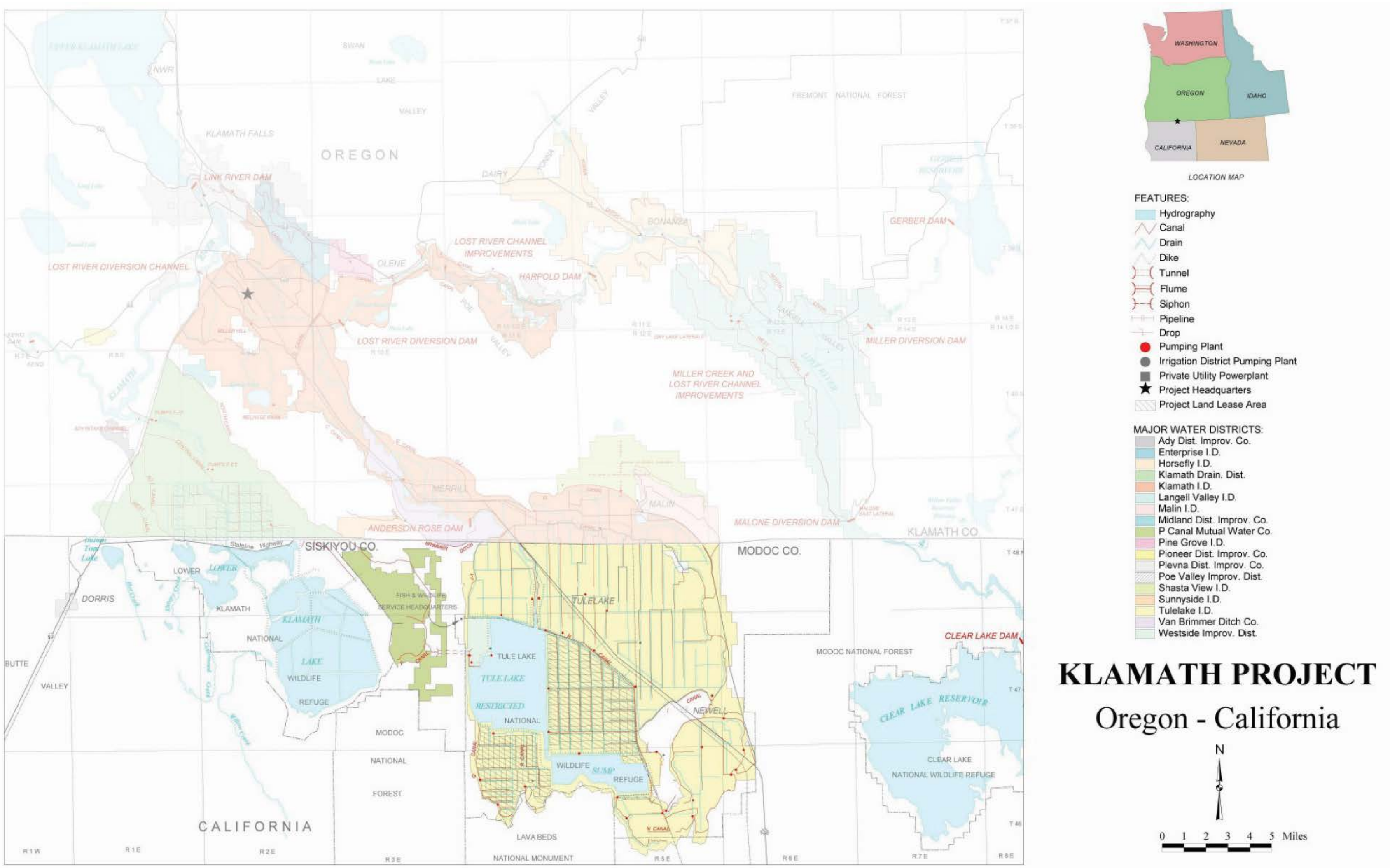

Figure 3.8-2. Water Supply/Water Rights Area of Analysis includes portions of the Klamath Irrigation Project within California. Source: USBR.

3.8.2 Environmental Setting

This section describes information related to existing water supply and water rights in the Area of Analysis. It also includes a brief introduction to the Upper Klamath Basin and the Klamath Irrigation Project, which delivers water from Oregon diversions to portions of California in the Upper Klamath Basin (e.g., Tule Lake and Lower Klamath Lake). This section includes a description of reservoir capacities, Biological Opinion (BiOp)-related water storage and release criteria, municipal water supply for the City of Yreka, and other water right holders along the Klamath River in the Area of Analysis.

3.8.2.1 Upper Klamath Basin

The Corrected Findings of Fact and Order of Determination in the Klamath River Basin General Stream Adjudication (Oregon Department of Water Resources 2014), sets forth the water rights in the Upper Klamath Basin diverted in Oregon. The highest priority water rights in the adjudication are those of the Klamath Tribes', who maintain water rights with a time-immemorial priority to support hunting, gathering, and fishing on their reservation. The USBR's Klamath Irrigation Project stores and delivers a significant amount of water in a water supply project that includes Upper Klamath Lake, Lake Ewauna, Keno Dam, and a host of irrigation canals that connect the Upper Klamath River with the Lost River systems. Average annual Project supply as reported in 2000, prior to BiOp-related storage and flow release criteria, was approximately 350,000 acre-feet (USBR 2000). Project supply is now controlled by BiOp criteria and varies on a yearly basis. In 2017 Project supply was 340,000 acre-feet, and 310,000 acre-feet in 2018 (USBR 2018b). The Klamath Irrigation Project provides irrigation water to approximately 230,000 acres of agricultural land in southern Oregon and northern California, and also supplies water to the Lower Klamath and Tule Lake National Wildlife refuges in California and Oregon (Figure 3.8-2) (USBR 2018b). The USFWS "walking wetlands" program is currently in use in the Lower Klamath National Wildlife Refuge and involves rotating areas of agricultural production with areas of marsh or treatment wetlands on refuge lands to maintain both higher crop yields with lower inputs of fertilizers and pesticides and high-quality wetlands for wildlife (Stillwater Sciences et al. 2013).

The 2013 Joint Biological Opinion (2013 BiOp) for operation of USBR's Klamath Irrigation Project sets minimum lake and river hydrologic conditions to avoid jeopardizing the continued existence of ESA-listed species and adverse modification of designated critical habitat, while providing for delivery of water for irrigation purposes consistent with historical operations, subject to water availability. The 2013 BiOp includes two distinct operational approaches for water management for the fall/winter (October through February) and spring/summer (March through September) time periods (see sections 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* and 3.6.2.2 *Basin Hydrology* for further details).

Lower Klamath Project

In addition to natural flows, flows through the Lower Klamath Project depend on water releases from Upper Klamath Lake by USBR, flows diverted to and returned from USBR's Klamath Irrigation Project's operations, the relatively small storage capacities of the Lower Klamath Project developments, and releases from Iron Gate Dam (FERC 2007). Approximately 98 percent of the available active surface water storage along the Klamath River is provided by Upper Klamath Lake behind Link River Dam. Keno, J.C.

Boyle, Copco No. 1, Copco No. 2, and Iron Gate reservoirs combined provide approximately two percent of the available active storage on the river. The State of Oregon has issued non-consumptive, hydropower water rights for J.C. Boyle reservoir. California has issued a water right license for diversion at Iron Gate Dam for power generation (1,800 cfs), hatchery operations (50 cfs), and refill of regulatory storage (3,300 cfs). PacifiCorp has filed statements of water diversion and use for pre-1914 direct diversion hydropower water rights for operation of the Copco No. 1 and Copco No. 2 facilities. Thus, none of the Lower Klamath Project facilities' water rights are for seasonal water storage or irrigation purposes. Appendix M contains more details and maps that display the water right locations.

Fall Creek Water Rights

Four water rights are located on Fall Creek: two non-consumptive rights for hydropower generation at PacifiCorp's Fall Creek powerhouse, which is not part of the Proposed Project, one for the City of Yreka's municipal water supply, and one for fish propagation at the Fall Creek Hatchery (see Appendix M).

City of Yreka

The City of Yreka receives its municipal water supply from Fall Creek, a tributary to the Klamath River in the Upper Klamath Basin that is approximately 23 miles northeast of the city (see also Section 2.7.7 *City of Yreka Water Supply Pipeline Relocation*). California Water Rights Permit 15379 allocates to Yreka up to 15 cfs, not to exceed 6,300 acre-feet per year from Fall Creek, year round. During the diversion period, the City of Yreka must ensure a minimum flow of 15 cfs, or the natural flow of Fall Creek whenever it is less than 15 cfs, measured by a gage approximately 1,000 feet upstream of Daggett Road. The priority of this water right dates from August 12, 1966. Yreka's Fall Creek diversion was completed in 1969 and the municipal water systems facilities include: 1) two impoundments; 2) an intake structure with fish screens, a pump, and pre-treatment facility; 3) a cathodic protection field at the Fall Creek Campground and Day Use Boat Ramp; and 4) a 24-inch pipeline that crosses on the eastern upstream end of Iron Gate Reservoir.

Fall Creek Hatchery

The California Oregon Power Company (COPCO; now PacifiCorp) built Fall Creek Hatchery (FCH) in 1919 as compensation for lost spawning grounds due to construction of Copco No. 1 Dam. Six of the original rearing ponds remain and they were last used from 1979 through 2003. California State Water Board License 11681 authorizes CDFW to divert up to10 cfs for non-consumptive, fish propagation use at Fall Creek Hatchery between March 15 and December 15 each year, not to exceed 5,465 acre-feet per year. The hatchery diverted 2 cfs during March through December from 2012 to 2017. The priority of this water right dates from January 5, 1979.

3.8.2.2 Mid and Lower Klamath Basins

The Area of Analysis in the Middle and Lower Klamath rivers includes only the mainstem of the Klamath River through these reaches (see Figure 3.8-1).

Generally, tributary discharge to the Klamath River increases substantially with distance downstream within the Mid and Lower Klamath basins, as described in Section 3.6.2.2 *Basin Hydrology*. The long-term average annual flow rate at Iron Gate Dam is approximately 1,970 cfs and is approximately 17,020 cfs at the mouth of the Klamath

River (USGS 2017). Like most rain and snow-pack-influenced basins in the western United State, the months of July through October generally have much lower flow than the winter and spring runoff months. Historical stream flows for the Klamath River are discussed in Section 3.6.2.2 *Basin Hydrology*.

Klamath River Water Rights

In California, water diverters are required to file annual reports or statements of diversion and use with the State Water Board, which are accessible, *inter alia*, through the Electronic Water Rights Information Management System (eWRIMS). In addition to the hydropower water rights discussed above, a query of eWRIMS provided 44 water right records that list the Klamath River or a California Lower Klamath Project reservoir (i.e., Iron Gate, Copco No. 1, and Copco No. 2 reservoirs) as their water source. 41 water right listings are located downstream of Iron Gate Dam and three are located upstream of Iron Gate Dam (Table 3.8-1). Appendix M contains the query results and maps that display the documented locations.

Table 3.8-1. Summary of Water Right Listings from California's Electronic Water Rights Information Management System (eWRIMS) that list the Klamath River or One of the California Lower Klamath Project Reservoirs as the Water Source.

Type of Water Right Listings[1]	Number of Claims
Statements of Diversion and Use	
Active Claims (Claimed)	23
Inactive	9
Post-1914 Appropriative	
Licensed	3
Permitted	1
Small Domestic Registrations	2
State Filing Applications (Unassigned)	10

Source: California Electronic Water rights information Management System (eWRIMS) (State Water Board 2017)

Notes:

[1] Status Definitions:

Active Claims (Claimed): Riparian and pre-1914 appropriative rights predate the Water Commission Act that established the water rights permitting system, and the precursor to the State Water Board. Riparian rights exist due to ownership of parcels abutting a watercourse. Entities that hold either of these rights are not required to obtain a permit from the State Water Board.

Inactive: Claimed riparian or pre-1914 right that are currently unexercised.

Licensed: A license indicates that the conditions of development of the project is complete and diversion and use has occurred, as contemplated under the permit.

Permitted: A permit is an authorization that allows for the development of a project to divert and use water with due diligence, under permitted conditions.

Registered: Entities can register to divert and use a small amount of water from a stream for domestic purposes or the use of a small amount of water for livestock. In such cases, the use is registered with the State Water Board and must follow conditions set by the CDFW to protect fish and wildlife.

State filing applications: State filing applications are made by the State Water Board in trust for the people of California, in order to preserve water for future use and development consistent with a coordinated plan such as the State's Water Plan or a County General Plan. If "assignment" of the state filing application is requested and approved, an applicant to develop a water right may use the water right priority of the state filing, allowing the new project to be senior to certain existing diverters.

A total of 32 Statements of Diversion and Use, including the hydropower rights for Copco No. 1 and No. 2, of water were filed with the State Water Board; nine of which are currently inactive. Of these 32 rights, 18 belong to individuals, 13 to corporations, and one with an incomplete record. Statements of Diversion and Use include claims to riparian water rights as well as claimed pre-1914 appropriative water rights. The requirements for filing Statements of Diversion and Use apply to federal agencies, but do not apply to rights that do not involve a diversion, such as federal reserved rights for instream flow.

There are three licensed appropriative water rights in the Area of Analysis: one for PacifiCorp at Iron Gate Dam (1957); one for the Klamath River Country Estates Owners Association Inc. (1960); and one for an individual. The Klamath Community Services District holds one permitted appropriative water right from 1968, and there is one private Small Domestic Registration water right from 2006.

It is expected that each of the active water rights listings discussed above would, and some of the inactive listings could, have associated intake facilities to draw water from the Klamath River; however, the specific type, location, and layout of each of these intake facilities is unknown.

There are ten state filed applications on the mainstem Klamath River, four in Humboldt County and six in Siskiyou County. Such state filings are to preserve water for future use and development consistent with a coordinated plan such as the State's Water Plan or a County General Plan. State filings hold water in reserve for future needs, and have a priority based on the date of filing. The state filings on the Klamath River all have priority dates of 1956. The ten state filing applications have not been "assigned" yet, meaning that no one has proposed developing water under the rights and received permission to use the 1956 date of priority.

Two of the state filings in Siskiyou County are for storage and later application to beneficial use of 60,000 acre-feet per year at the current location of Iron Gate Dam. One is for power production, while the other is for irrigation, industrial, domestic, municipal, recreational, and fish and wildlife use in the Shasta Valley. No diversion infrastructure exists, or is planned for construction, involving these state-filed applications.

There is also a transient non-community public water system at the Randolph E. Collier rest area on Interstate 5, near the town of Hornbrook. This water system is regulated by the State Division of Drinking Water.

The Proposed Project would not affect the water supplies for these state filings or non-community public water system.

Federal Reserved Rights for Native American Tribes

Hoopa Valley Tribe and Yurok Tribe

The Klamath River Reservation, consisting of a strip of land beginning at the Pacific Ocean and extending one mile in width on each side of the Klamath River for a distance of approximately 20 miles, was established by Executive Order in 1855. The Klamath River Reservation was established on Yurok ancestral lands. In 1876, a second executive order established the Hoopa Valley Indian Reservation, a 12-mile square area southeast of the Klamath River Reservation, beginning at the confluence of the Klamath and Trinity Rivers, and bisected by the Trinity River. A third executive order in 1891 created an extended Hoopa Valley Reservation, which encompassed the original Hoopa Valley Indian Reservation, the Klamath River Reservation, and a strip down the Klamath River from the Klamath-Trinity confluence connecting the two original reservations. In 1988, Congress passed the Hoopa-Yurok Settlement Act, 25 U.S.C. 1300i et seq., which partitioned the extended reservation between the Hoopa Valley Tribe and Yurok Tribe, with the Yurok Reservation comprising the original Klamath River Reservation and the connecting strip, and the Hoopa Reservation comprising the original 12-mile square area. The federal courts have confirmed that the United States reserved fishing rights for the Hoopa Valley and Yurok tribes when it set aside reservations along the Klamath and Trinity Rivers. The Department of the Interior has found that the original orders setting aside the Hoopa Valley and Yurok reservations also reserved rights for instream flows sufficient to sustain fish within the reservations. Although there has been no formal adjudication to quantify and determine the priority of the Yurok and Hoopa Valley tribes' fishing-related water rights, the recognition of such rights is consistent with the federal precedent set in *United States v. Adair*.

3.8.3 Significance Criteria

Impacts to water supply and/or water rights would be considered significant if they result in the following:

- Causing unreasonable injury to existing water rights[137].
- Decreasing water supplies beyond what is needed for public health and safety (human consumption, cooking, and sanitation) for the current population.

In determining the criteria for significance, the lead agency looked to applications of the No Injury Rule and the reasonableness standard in California water law, to the California Constitution Article X, section 2, and to human right to water (Water Code, section 106.3). The assessment of the Proposed Project's effects on Safe Drinking Water Act requirements is presented in Section 3.2 *Water Quality*. The assessment of the effects of the Proposed Project on fire suppression is presented in Section 3.17 *Public Services* and Section 3.21 *Hazards and Hazardous Materials*.

3.8.4 Impacts Analysis Approach

The impacts analysis of water supply and water rights discusses the potential impacts of the Proposed Project to river flows and water diversions throughout the Area of Analysis, and whether these impacts could affect existing water rights or water supplies. The analysis is based on flow rates and water supply delivery data from the hydraulic modeling completed by USBR (2012), along with the methods and assumptions that were utilized in the model. USBR applied a one-dimensional HEC-RAS model using historical flow data as input to the model. The modeling compared river flow rates, assuming KBRA flows, for the Proposed Project and the No Project Alternative. The model's average daily instream flow data help describe how the flows would change under each alternative. USBR used these data to assess whether changes to instream flows as a result of the Proposed Project would be adequate to meet water rights and

[137] An existing water right is one that was in existence at the time of the Notice of Preparation.

water supply requirements. USBR (2012) also compared water supply diversions to baseline conditions and water rights to determine impact significance.

The 2013 BiOp changed the flow regime under which dam removal would occur (i.e., KBRA flows are no longer anticipated). However, the differences in hydrology between KBRA and 2013 BiOp flows are minor (see Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, for further details regarding KBRA and 2013 BiOp flows) and thus do not affect the analysis of future water supply or water rights under the Proposed Project.

Evaporation from the surface of the Lower Klamath Project reservoirs under existing conditions is approximately 11,000 acre-feet/year, and after dam removal evapotranspiration in the same reaches is expected to be approximately 4,800 acre-feet/year, resulting in a gain in flow to the Klamath River of approximately 6,200 acre-feet/year (USBR 2012). The increase in flow is equal to approximately 8.5 cfs on average over a year or approximately 0.4 percent of the average annual Klamath River flow measured downstream of Iron Gate Dam (USGS Gage No. 11516530) between 1961 and 2017. At this point it is speculative where this additional water will be available in the basin. If no change were to be made to the 2013 BiOp for the Klamath Irrigation Project, the additional water would become available to Klamath Irrigation Project operations, and not impact downstream flows. However, the 2013 BiOp is currently under review, and is scheduled for additional review upon implementation of the Proposed Project. It is unclear whether ongoing or planned revisions to the BiOp will change streamflow requirements in light of this additional water availability, and where the measured points of compliance for river flow will be absent Iron Gate Dam (making it unclear whether the additional water will accrue to the system above or below such compliance points). Therefore, while noting the anticipated increase in available water, this EIR does not apply the additional water being made available to any particular use or reach.

The following sources were assessed to determine the scope of existing local plans and policies relevant to the Proposed Project:

- Del Norte County General Plan (Mintier & Associates et al. 2003):
  - Section 1 Natural Resources/Conservation
    - Water Resources Policies: 1.B.5,
  - Section 7 Public Facilities and Services
    - Water Supply and Delivery Policies: 7.B.1, 7.B.3, 7.B.4, 7.B.5, 7.B.8
- Humboldt County General Plan for Areas Outside of the Coastal Zone (Humboldt County 2017):
  - Chapter 11 Water Resources Element
    - Water Resources and Land Use Policies: WR-P1, WR-P2, WR-P3, WR-P4, WR-P5, WR-P6, WR-P7, WR-P8, WR-P9, WR-P10, WR-P11, WR-P12, WR-P14, WR-P18, WR-P21
    - Watershed Planning Policies: WR-P22, WR-P23, WR-P24, WR-P25
    - Public Water Supply Policies: WR-P26, WR-P27
    - Water Exports Policies: WR-P29, WR-P32, WR-P33, WR-P34
    - Water Resources and Land Use Standards: WR-S1, WR-S2, WR-S3, WR-S5

    - Water Exports Standards: WR-S12
- Siskiyou County General Plan (Siskiyou County 1980)
  - Chapter 3 Land Use Policies
    - Wildfire Hazard Policies: 30

Most of the aforementioned policies and standards are stated in generalized terms, consistent with their overall intent to protect water supply resources and water rights. By focusing on the potential for impacts to specific water supply and water rights issues within the water supply/water rights Area of Analysis, consideration of the more general local policies listed above is inherently addressed by the specific, individual analyses presented in Section 3.8.5 *Potential Impact and Mitigation;* and the more general local policies are not discussed further.

3.8.5 Potential Impacts and Mitigation

Potential Impact 3.8-1 Dam removal could change the amount of surface water flow available for diversion under existing water rights in the mainstem Klamath River within the Hydroelectric Reach and downstream from Iron Gate Dam.

Hydroelectric Reach

PacifiCorp has three water rights on the Klamath mainstem upstream of Copco No. 1 Reservoir for irrigation and stock watering.

As noted above, there are five water rights associated with the Lower Klamath Project. Three PacifiCorp Statements of Water Diversion and Use are associated with hydropower and associated reservoirs at Copco No. 1 and Copco No. 2 facilities. PacifiCorp has a water right license at Iron Gate Dam for diversions from the Klamath River that include 1,800 cfs for power generation, 50 cfs for fish propagation facilities, and 3,300 cfs to refill regulatory storage space in Iron Gate Reservoir. Additionally, PacifiCorp has a Statement of Diversion and Use at Iron Gate Dam of 48 cfs for fish culture. Under the Proposed Project, power generation and associated water storage at Copco No. 1, Copco No. 2, and Iron Gate reservoirs would cease, such that the prior water supply requirements for these activities would no longer be needed. Because hydropower water rights are non-consumptive, ceasing to use the water for power production purposes would not have a water supply availability impact for downstream users.

As part of the Proposed Project, the Reservoir Area Management Plan includes restoration actions that would utilize Klamath River water for short-term (i.e., during dam removal year 2 and 1−5 years following dam removal) irrigation of riparian revegetation areas in the Lower Klamath Project reservoir footprints (Appendix B: *Definite Plan-Appendix H* and Section 2.7.4 *Restoration Within the Reservoir Footprint*). The water supply to meet irrigation needs would be the short-term exercise of riparian rights available to the KRRC as the owner of the property at the time of the diversion. Evapotranspiration (ET) of the planted riparian species represents the consumptive water loss associated with revegetation irrigation. Evapotranspiration data from a regional USBR AgriMet station (USBR 2018a), correlated to the Iron Gate and Copco No. 1 reservoirs area using a local weather station, provide a range of reasonable ET rates (i.e., 0.075 to 0.142 ft/day) for riparian species proposed for planting. Based on this calculation, an equivalent of up to approximately 2-4 cfs would be lost due to ET in the irrigated riparian revegetation areas at Iron Gate and Copco No. 1 reservoirs during the April through October irrigation season. This loss due to ET represents a 0.22 to 0.44 percent reduction in water supply available to water right holders downstream of Iron Gate Dam, and therefore would not be a significant impact.

Water supply for fish propagation and fish culture would continue to be required for eight years following dam removal, but would require changes in diversions due to the removal of Iron Gate Reservoir. Currently 50 cfs is diverted from Iron Gate Reservoir for use at the Iron Gate Hatchery. Under the Proposed Project, up to 8.75 cfs of water would be diverted from Bogus Creek to operate Iron Gate Hatchery at reduced production levels. Up to 9.25 cfs of water would be diverted from Fall Creek (downstream of the City of Yreka's intake) to reopen and operate Fall Creek Hatchery (Section 2.7.6 *Hatchery Operations*). The diverted water would be returned to Fall Creek either at a proposed new settling pond location or at the fish ladder on the downstream side of the hatchery. Water diverted from Bogus Creek would be under riparian rights (Appendix B: *Definite Plan*). The Fall Creek Hatchery diversion would be under CDFW's existing appropriative water right for 10 cfs and riparian rights. The water diverted for hatchery use is non-consumptive, and therefore would not change the amount of water available for diversion downstream of the point of return for the waters. For either hatchery diversion, there are no other water users between the point of diversion and the point of return.

Middle and Lower Klamath River

Using historical flow data to create a set of flows under future operational prescriptions, USBR (2012) compared modeled surface water flow rates at Iron Gate Dam under the Proposed Project to a dams-in scenario. Modeling results indicate that under the Proposed Project, average monthly flows in the Klamath River just downstream of Iron Gate Dam would only slightly increase or decrease (typically less than approximately 15 percent) depending on month and water year type, compared to existing conditions. The anticipated small relative changes in Klamath Rivers flows are due to the fact that the Lower Klamath Project reservoirs were not designed, nor are they operated, as seasonal storage reservoirs for maintaining downstream flows for irrigation or drinking water diversions. As a whole, the Lower Klamath Project is primarily operated as a run-of-the-river operation, with inflows essentially matching outflows below Iron Gate Dam. Thus, the Lower Klamath Project has only a small effect on daily, monthly, seasonal, or annual flow conditions downstream of Iron Gate Dam. USBR (2012) modeling results indicate that at Seiad Valley, approximately 62 river miles downstream of Iron Gate Dam, surface water flow rates under the Proposed Project would be nearly identical to those under existing conditions.

Under existing conditions, flow rates just downstream from Iron Gate Dam are the lowest within the Middle and Lower Klamath River and therefore provide a conservative estimate of available water supply when comparing to downstream diversion amounts. The monthly diversion flow rate associated with all of the active and inactive water rights in the Middle and Lower Klamath River, aside from the reserved (but unassigned) state filings and PacifiCorp's Iron Gate power diversion water rights, is approximately 69 cfs (based on water right information in Appendix M). The vast majority of water is diverted in the reach between Iron Gate Dam and Seiad Valley, where during summer months (i.e., July−August), usage typically doubles[138], resulting in an estimated peak short-term diversion of approximately 138 cfs if all users doubled their water diversion rate during the same period. This estimate of peak flow diversion would likely be lower during wetter water years, since not all users would be likely to divert the maximum amount during summer months. Comparing the peak potential diversion flow (138 cfs) to the low-flow condition of a dry water year type immediately downstream of Iron Gate Dam (900 cfs, or a 90 percent exceedance flow per the 2013 BiOp), the diversions would represent approximately 15 percent of Klamath River flows in the upstream portion of this reach under the Proposed Project. Because the amount of flow diverted for water rights users between Iron Gate Dam and Seiad Valley would be relatively small (i.e., approximately 15 percent of the flow in the Klamath River in the upstream portions of this reach during dry years with low-flow conditions), water right users are not likely to be injured. Additionally, there would be no lack of water availability for public health purposes due to limited flow diversion capacity resulting from flow changes as part of the Proposed Project.

Note that the USBR (2012) modeling effort assumed KBRA flows, rather than the 2013 BiOp flows under which the upstream Klamath Irrigation Project (and hence the Lower Klamath Project) currently operates. Compared to KBRA flows, the 2013 BiOp slightly increases the annual average water supply by about 9,000 acre feet. During summer months (July and August) in dry years, the 2013 BiOp requires a higher minimum flow of 900 cfs at Iron Gate Dam, compared to 824 cfs under KBRA (see also Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*). Overall, the hydrologic differences between KBRA flows and those implemented under the 2013 BiOp are small, decrease the relative effect of other diversion in the river in summer, and do not change the assessment of Proposed Project impacts on surface water flows available for diversion under existing water rights in the Klamath River downstream of the Oregon-California border. Furthermore, under the No Project alternative, flow releases would still be controlled by the 2013 BiOp, and therefore, the same quantity of Klamath River flow would be available for downstream water rights.

During the extreme drought of 2014−2016, PacifiCorp coordinated late-2014 releases from Iron Gate and Copco No. 1 dams (see also Potential Impact 3.8-2), which provided a small degree of flexibility for managing irrigation water in the Upper Klamath Basin by allowing USBR to postpone releasing water for environmental purposes at Keno Dam (USBR 2018c). This had the effect of making approximately 15,400 acre-feet of additional irrigation water available for water users in the Klamath Irrigation Project, including users in California (although the diversions themselves occur in Oregon). A comparable water borrowing arrangement between PacifiCorp and USBR for approximately 20,000 acre-feet also occurred in 2018. It is unclear if comparable water borrowing would occur in the future due to multiple constraints detailed by USBR (2018c), and further discussed below in Potential Impact 3.8-2. However, and as previously stated in Section 3.8.1 *Area of Analysis*, removal of the Lower Klamath Project dams would not affect USBR's central role in providing BiOp flows to the Klamath River and would not place flow obligations on small agricultural diverters in tributaries to the Klamath River.

[138] The increase during July and August is an average based on permitted diversion amounts and reported values on Statement Diversion and Use forms available on eWRIMS for the Klamath River.

Significance
No significant impact

Potential Impact 3.8-2 Dam removal could change the amount of surface water flow available for diversion from Upper Klamath Lake and/or Keno Reservoir to California water users in the USBR Klamath Irrigation Project.
As described in Potential Impact 3.8-1 and Section 3.8.2 *Environmental Setting*, PacifiCorp has claimed pre-1914 water rights for hydropower production at Copco No. 1 and Copco No. 2 dams, and a water right license for diversion at Iron Gate Dam for hydropower, fish propagation, fish culture, and refilling regulatory storage space. Neither the Statements of Diversion and Use nor the Iron Gate Dam license include seasonal storage or irrigation use. However, two times in recent years, PacifiCorp has agreed to operate its hydropower projects in a manner that supports increased irrigation deliveries to the Klamath Irrigation Project.

In the fall of 2014, PacifiCorp agreed to release approximately 15,400 acre-feet of water from Iron Gate and Copco No. 1 reservoirs to assist USBR in meeting requirements of the 2013 BiOp (USBR 2014). This water was then repaid from storage in Upper Klamath Lake in February and November of 2015. Release of the 15,400 acre-feet from Iron Gate and Copco No. 1 reservoirs extended irrigation water supply to Klamath Irrigation Project water users during severe drought conditions (USBR 2014).

In April 2018, USBR coordinated with NMFS, USFWS, PacifiCorp, Klamath Basin Tribes, water users, and other stakeholders regarding the temporary release of approximately 10,000 acre-feet from the Lower Klamath Project reservoirs, in order to enable charging of Klamath Irrigation Project irrigation canals in late April and May without violating 2013 BiOp requirements for Upper Klamath Lake elevation or Klamath River flow below Iron Gate Dam. An additional 10,000 acre-feet was released from the Lower Klamath Project reservoirs in late-May to allow for continued Klamath Irrigation Project deliveries without violating 2013 BiOp requirements (USBR 2018c).

The aforementioned releases did not result in a change to Klamath River flows or water supply downstream of Iron Gate Dam since USBR is obligated under the 2013 BiOp to release the water into the Klamath River. If PacifiCorp had not released the flows from Iron Gate and Copco No. 1 reservoirs in the fall of 2014 and spring of 2018, then USBR would have released the flows at Keno Dam and the water would have traveled downstream through the Lower Klamath Project reservoirs to be discharged at Iron Gate Dam, regardless.

Ultimately, precipitation, irrigation needs, and the 2013 BiOp flow requirements determine the amount of surface water flow available for diversion from Upper Klamath Lake and/or Keno Reservoir to the USBR Klamath Irrigation Project. During extreme dry years, any reduction in available water for existing water rights would result in additional water being drawn from Upper Klamath Lake until lake levels drop to 4,137.72 feet (1,261.5 meters), at which point USBR would adjust water deliveries to the Klamath Irrigation Project to prevent the lake elevation from dropping below that value (NMFS and USFWS 2013). Decreased water supply caused by such an adjustment would potentially result in reduced deliveries to Klamath Irrigation Project water users (irrigators and wildlife refuges in Oregon and California).

The Lower Klamath Project has no obligation to apply the water stored in its reservoirs to meeting USBR's 2013 BiOp requirements, and PacifiCorp has indicated that any future borrowing of water from Lower Klamath Project reservoirs would be predicated upon a definitive, rapid refill schedule, and compensation to PacifiCorp for the value of lost power generation due to reduced Lower Klamath Project reservoir capacity, both of which limit the benefit to USBR of borrowing water from the Lower Klamath Project. This places uncertainty as to whether the water-borrowing operation that has occurred in two years since implementation of the 2013 BiOp will continue. Additional uncertainty comes from potential necessary changes to water rights to accommodate more than sporadic emergency use of the reservoirs for other than hydroelectric purposes. Despite the stated limitations of borrowing water from the Lower Klamath Project reservoirs, and the uncertainty of what, if any, permissions would be necessary to affect regular implementation of the operations, dam removal under the Proposed Project would preclude the potential option of utilizing the Lower Klamath Project reservoir water supply to help meet 2013 BiOp flow requirements and thereby extend the available water supply to the USBR Klamath Irrigation Project.

Most Klamath Irrigation Project deliveries are to users in Oregon; however, some users, including agricultural users, wildlife refuges, and a combination of these two users in the "walking wetlands" program, are in California. There could be times in which users in California—agricultural users, wildlife refuges, or both—are next in line for the water in a year that Lower Klamath Project operators could make it available under a comparable water borrowing operation as described above. Additionally, users in California benefit from runoff from Klamath Irrigation Project deliveries in Oregon portions of the Lost River Sub-Basin. Water users in California often turn to groundwater pumping in times of surface water shortages. The Tulelake Basin is designated a medium priority basin under the Sustainable Groundwater Management Act (SGMA), in part because of declining groundwater levels and high volume groundwater extractions (DWR 2014). Under SGMA, the basin must be managed under a groundwater sustainability plan by January 31, 2022 (Wat. Code, § 10720.7, subd. (a)(2)). Thus, groundwater may become limited as an alternative source in the future, as the basin adjusts to sustainable pumping levels. Additionally, dry year groundwater pumping may be financially infeasible for wildlife refuges and some farms. Therefore, for some California users in some years in which Lower Klamath Project owners could have chosen to coordinate supplies, there may be less water available with dam removal than otherwise. Despite this minor chance of a reduction, there would be no legal injury to the Klamath Irrigation Project users because the Lower Klamath Project operators are not required to temporarily supplement water deliveries, per the 2013 BiOp flow requirements. Additionally, there is no indication that water would not be available for public health purposes, absent supplementation of Klamath Irrigation Project available water.

Significance

No significant impact

Potential Impact 3.8-3 Release of stored sediment during reservoir drawdown could change Klamath River geomorphology and affect water intake pumps downstream from Iron Gate Dam.

Reservoir drawdown would release the sediment stored behind the Lower Klamath Project dams into downstream reaches of the Klamath River. Reservoir drawdown activities would begin on January 1 of the drawdown year at J.C. Boyle, Copco No. 2, and Iron Gate dams and on November 1 of the year prior at Copco No. 1 Dam (see

Section 2.7.2 *Reservoir Drawdown*). During this period, individual downstream intake facilities could be affected by fine sediment deposits, causing operational problems. USBR (2012) conducted modeling of the reservoir drawdown and erosion of reservoir sediment. The released sediment would likely exceed the carrying capacity of the river during some water year types, and would result in sedimentation and particle settling in slow-moving downstream areas. However, the fine fraction of the released sediment (silt and clay) would not be expected to deposit in substantial amounts in the river channel. The majority of this material would be transported to the ocean and would not interact substantially with the river bed (see also Section 3.11.5 *[Soils, Geology, and Mineral Resources] Potential Impacts and Mitigation*)

If drawdown occurred in a dry year, deposition of sands and coarser sediment would be expected in the reach from Iron Gate Dam to as much as eight miles downstream from the dam, near the confluence with Cottonwood Creek (see also Potential Impact 3.11-5). The amount of sediment deposition would decrease with distance from Iron Gate Dam. Little to no sediment deposition is expected in the reach between J.C. Boyle Dam and Copco No.1 Reservoir (USBR 2012). There are 15 water rights registered on the reach from Iron Gate Dam to Cottonwood Creek: five are listed as inactive, two are state filings with the State Water Board, and two are associated with PacifiCorp's Iron Gate Dam facility and fish hatchery. There are no facilities for the state filings, and the Iron Gate Dam diversions would cease under the Proposed Project. The remaining six water rights are associated with domestic, irrigation, and/or fire protection use. There is the potential for intake facilities for the active and inactive water right diversions to be affected by sediment deposition, although there is insufficient information on exact intake facility configuration and too much uncertainty in the modeling to determine whether any particular diversion will be affected.

The analysis of potential sediment impacts to water intake pumps considered the results of detailed hydraulic, hydrologic, and sediment transport modeling (USBR 2012); however, even small deviations in localized sediment deposition at a site could affect the ability to use diversion facilities, which could result in injury to an existing water right or decrease water supplies beyond what is needed for public health and safety. This would be a significant impact. Implementation of Mitigation Measure WSWR-1 would reduce the potential for this impact to occur because it requires identification of impacts reported by water rights holders following dam removal and replacement of affected water supplies.

Mitigation Measure WSWR-1 – Water Supply Monitoring and Management
The KRRC shall identify all points of diversion on the Klamath River listed in the Electronic Water Rights Information Management System (eWRIMS). The KRRC shall contact all water rights holders with points of diversion on the Klamath River prior to drawdown of the reservoirs to determine whether the water right holder is interested in working with the KRRC to evaluate potential Proposed Project impacts to the water right holder. If potential impacts are identified, the KRRC shall provide temporary accommodations (e.g., replacement water, settling basins, etc.) to address them. During and following dam removal, the KRRC shall investigate any impacts reported by a water right holder. If the investigation confirms an adverse impact has occurred as a result of dam removal, the KRRC shall immediately provide any necessary replacement of water for health and safety for domestic or municipal diversions, and promptly implement measures to reduce impacts and allow the water right holder to divert water in the same manner (e.g., amounts, suitable quality, and timing) as before dam removal.

Prior to and annually for the first two years following drawdown, the KRRC shall submit a report to the State Water Board on implementation of the activities described above.

Significance

No significant impact with mitigation

Potential Impact 3.8-4 Relocation of the City of Yreka water supply pipeline after drawdown of Iron Gate Reservoir could affect water supply.

The existing water supply pipeline for the City of Yreka passes under the Iron Gate Reservoir and would have to be relocated prior to the decommissioning of the reservoir to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. Three alternatives have been developed for proposed modifications to the pipeline (see Section 2.7.7 *City of Yreka Water Supply Pipeline Relocation*). The alternatives all include a new pipeline that would be tunneled under the river bed, suspended along an existing road bridge, or suspended along a new utility bridge. The KRRC would determine the preferred alternative in consultation with the City of Yreka (Appendix B: *Definite Plan*). Based on the Detailed Plan for Dam Removal (USBR 2012a), the existing flat panel fish screens for the water supply intakes at Dams A and B on Fall Creek may not meet current regulatory agency screen criteria for anadromous fish. While the fish screens have recently been updated, their compliance to NMFS, USFWS, and CDFW screen criteria for anadromous fish still needs to be confirmed. These fish screens would require updates, if found to be non-compliant (Appendix B: *Definite Plan*). Regardless, the water quantity and quality diverted from Fall Creek would not change. During connection of the new pipeline, the KRRC anticipates that the existing pipeline would be disconnected for less than 12 hours during the winter season. The available water in storage is able to supply the City of Yreka for up to 60 hours during the winter (see also Appendix B: *Definite Plan*). However, because the exact plans for pipeline re-routing are incomplete, it is not possible to determine the reasonableness of the assumed timeframe for pipeline disconnection. If the disconnection were to cause a supply interruption, this would constitute a significant impact Implementation of Mitigation Measure WSWR-2 would reduce this potential impact to less than significant.

Mitigation Measure WSWR-2 – City of Yreka Water Supply.

Prior to initiating drawdown of the Lower Klamath Project reservoirs, the KRRC shall construct a new, fully operational replacement pipe for the City of Yreka's current water supply pipeline for the section of pipe that crosses Iron Gate Reservoir. The new replacement pipeline section shall be connected to the existing City of Yreka water supply pipeline and installed in a location that prevents river flows during and after drawdown from affecting the City of Yreka's water supply.

Any work the KRRC undertakes to ensure that the City of Yreka water supply intakes' screens comply with fish screen criteria shall be completed within the water delivery outage period specified above.

Except as provided in this Mitigation Measure, the KRRC shall ensure uninterrupted water supply during replacement of the pipeline section, any required intake screen modifications, and throughout Project implementation. A short water delivery outage is necessary to make the final connections following construction of the new pipeline. The KRRC shall limit the water delivery outage to a maximum of 12 hours, unless the KRRC receives prior approval for a longer outage from the State Water Board, based on detailed information that the outage proposed will not interfere with City of Yreka's ability to supply water. The KRRC shall coordinate the water delivery outage period with the City of Yreka to ensure the City of Yreka has an adequate supply of water stored to cover the maximum water delivery outage period, with adequate buffer.

Significance

No significant impact with mitigation

Potential Impact 3.8-5 Removal and potential replacement of recreational facilities currently located on the banks of the existing reservoirs could affect water supply and/or water rights.

The existing recreational facilities provide camping, fishing, and boating access for recreational users of the reservoirs and currently do not use surface water supplies. Once the reservoirs are drawn down, these facilities would be removed. The Proposed Project (Appendix B: *Definite Plan – Section 7.6.5*) includes the potential for new whitewater boating put-in/take-out sites and fishing access sites. Since these uses are similar to the sites being removed, they are likely also not to require surface water supplies. To the extent that there was water provided for public use at the recreational sites, such use would likely be *de minimus*.

Significance

No significant impact

3.8.6 References

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3.9 Air Quality

This section focuses on potential air quality impacts from implementing the Proposed Project. Section 3.10 of this EIR discusses greenhouse gas emissions. The State Water Board did not receive comments related to air quality during the NOP public scoping process (Appendix A).

3.9.1 Area of Analysis

Criteria air pollutants and toxic air contaminants (TACs) typically have localized air quality effects and relatively short atmospheric lifetimes (approximately one day). For this reason, the Area of Analysis for air quality includes areas within and adjacent to the Proposed Project Limits of Work (Figure 3.9-1), where construction activities would occur, which are located in Siskiyou County, California. As pollutants can travel on air currents away from the place of generation, the Area of Analysis includes Siskiyou County as a whole, along with Klamath County, Oregon where construction activity related to the removal of J.C. Boyle Dam would occur (Figure 3.9-1). Note that the portion of Proposed Project Limits of Work in Oregon is only being considered to the extent that conditions in this area influence air quality in Siskiyou County, California.

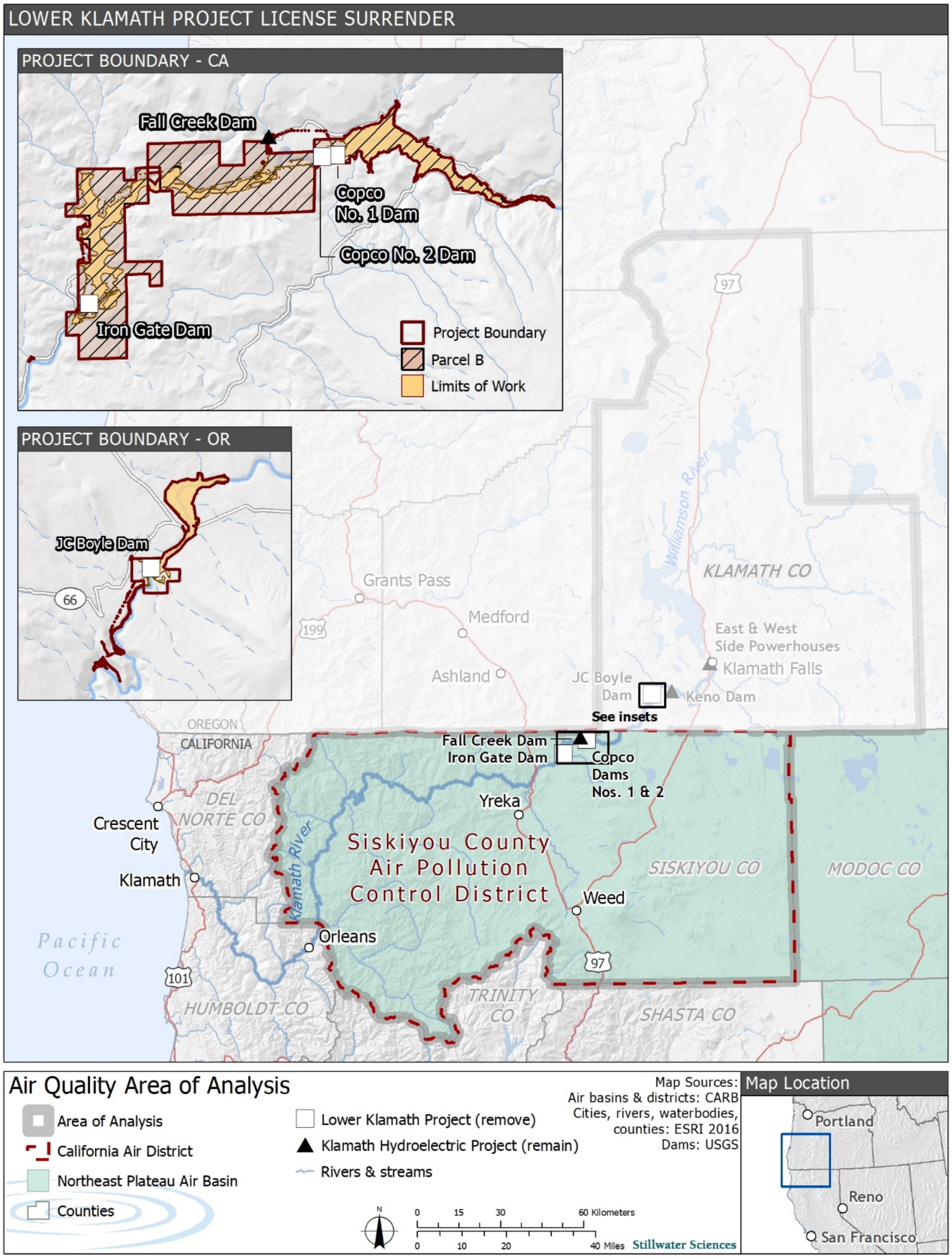

Figure 3.9-1. Area of Analysis for Air Quality.

3.9.2 Environmental Setting

This section provides a description of the environmental setting for air quality in the Area of Analysis, including a brief overview of existing air quality conditions in the portion of the Klamath Basin in California to set the stage for subsequent impact analyses. As Proposed Project construction activities in California would occur in Siskiyou County, this section focuses on the environmental setting in this county.

Ambient concentrations of air pollutant emissions are determined by the amount of emissions released by various sources and the atmosphere's ability to transport and dilute such emissions. In Siskiyou County, the terrain is dominated by volcanic peaks (e.g., Mount Shasta) and forested mountains, with agricultural activities (including rangeland) primarily in areas that are not wooded. Natural factors that affect transport and dilution of air pollutant emissions include terrain, wind, atmospheric stability, and sunlight. Also, air quality is influenced by natural factors, such as topography, meteorology, and climate, in addition to the amount of emissions released by existing air pollutant sources, as discussed separately in this section. The climate of Siskiyou County generally features hot summer days with cool nights and mild winters in the low valleys while the mountainous areas have cool summers and severe winters.

3.9.2.1 Meteorology

The climate in Siskiyou County is characterized by moderately wet winters and dry summers. Approximately 75 percent of the annual total rainfall occurs between November and April. Between June and September, normal rainfall typically is less than one inch per month. Temperatures in Siskiyou County average approximately 60 degrees Fahrenheit (°F) annually, with summer highs in the low 90°F and winter lows in the mid 40°F. Precipitation averages approximately 20 inches per year, although annual precipitation varies markedly from year to year (World Climate 2016). Annual average wind speeds in Siskiyou County are approximately 6.1 miles per hour and predominantly blow from the south. The average wind speed ranges from a low of 5.0 miles per hour in the fall to a high of 7.7 miles per hour in the spring (Western Regional Climate Center 2016).

3.9.2.2 Criteria Air Pollutants

The Clean Air Act requires the U.S. Environmental Protection Agency (USEPA) to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants (also known as "criteria air pollutants") (USEPA 2018). Concentrations of criteria air pollutants are used as indicators of ambient air quality conditions. A brief description of each criteria air pollutant (i.e., source types, health effects, and future trends) is provided below, followed by Section 3.9.2 *Environmental Setting* which describes the air pollutant standards, and subsequent sections that describe whether Siskiyou County complies with the standards.

Ozone

Ozone (O_3) is a photochemical oxidant - a substance whose oxygen combines chemically with another substance in the presence of sunlight. In the lower atmosphere, ozone is the primary component of smog. Ozone is not emitted directly into the air but is formed through complex chemical reactions between certain emissions, known as "precursor emissions," in the presence of sunlight. The precursor emissions for ozone are reactive organic gases (ROG) and nitrogen oxides (NO_X). ROGs are volatile organic compounds that are photochemically reactive. ROG emissions result primarily from incomplete combustion and the evaporation of chemical solvents and fuels. Common sources of ROG emissions include solvents, pesticides, the burning of fuels, and organic wastes. NO_X is a group of gaseous compounds of nitrogen and oxygen that result from the combustion of fuels. Common sources of NOx emissions include emissions from burning of fuel in cars, trucks, buses, power plants, and off-road equipment (USEPA 2018).

Ozone located in the upper atmosphere (stratosphere) shields the earth from harmful ultraviolet radiation emitted by the sun. However, ozone located in the lower atmosphere (troposphere) is a major health and environmental concern. As described below, breathing ozone can trigger a variety of health problems, particularly for children, elderly, and people of all ages who have lung disease such as asthma. Ground level ozone can also have harmful effects on sensitive vegetation and ecosystems, including forests, parks, wildlife refuges, and wilderness areas. Ozone can especially cause damage during the growing season (USEPA 2018).

The adverse health effects associated with exposure to ozone pertain primarily to the respiratory system. Scientific evidence indicates that ambient levels of ozone affect not only sensitive receptors, such as people with asthma and children, but healthy adults as well. Exposure to ambient levels of ozone ranging from 0.10 to 0.40 parts per million (ppm) for one or two hours has been found to substantially alter lung function by increasing respiratory rate and pulmonary resistance, decreasing tidal volume, and impairing respiratory mechanics. Ambient levels of ozone above 0.12 ppm are linked to symptomatic responses that include such symptoms as throat dryness, chest tightness, headache, and nausea. In addition to these adverse health effects, ozone exposure can cause an increase in the permeability of respiratory epithelia (i.e., the thin tissue forming the outer layer of the body's respiratory system); such increased permeability leads to an increase in the respiratory system's responsiveness to challenges and the inhibition of the immune system's ability to defend against infection (Godish 2004).

Meteorology and terrain play a major role in ozone formation in the troposphere (i.e., at ground level). Generally, low wind speeds or stagnant air coupled with warm temperatures and clear skies provide the optimum conditions for formation; therefore, summer generally is the peak ozone season. Peak ozone concentrations often occur far downwind from the precursor emissions due to the time it takes for reactions to complete. Therefore, ozone is a regional pollutant that often affects large areas. In general, ozone concentrations over or near urban and rural areas reflect an interplay of emissions of ozone precursors, transport, meteorology, and atmospheric chemistry.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless, and poisonous gas, produced by incomplete burning of carbon in fuels, primarily from internal-combustion engines used for transportation. In fact, 77 percent of nationwide CO emissions are from transportation. The other 23 percent of emissions are from wood-burning stoves, incinerators, and industrial sources.

CO enters the bloodstream through the lungs by combining with hemoglobin, a component of red blood cells, which normally carries oxygen to the red blood cells. CO combines with hemoglobin much more readily than oxygen does, resulting in a drastic reduction in the amount of oxygen available to the cells. Adverse health effects associated with exposure to CO concentrations include symptoms such as dizziness, headaches, and fatigue. CO exposure is especially harmful to individuals who suffer from cardiovascular and respiratory diseases (USEPA 2018).

The highest CO concentrations generally are associated with the cold, stagnant weather conditions that occur in winter. In contrast to ozone, which tends to be a regional pollutant, CO tends to cause localized problems.

Nitrogen Dioxide

Nitrogen Dioxide (NO_2) is a brownish, highly reactive gas that is present in all urban environments. The major human-made sources of NO_2 are combustion devices, such as boilers, gas turbines, and reciprocating internal-combustion engines (mobile as well as stationary). Combustion devices emit primarily nitric oxide (NO), which reacts with oxygen in the atmosphere to form NO_2 (USEPA 2018). The combined emissions of NO and NO_2 are referred to as NO_X, which is reported as equivalent NO_2. Since NO_2 is formed and depleted by reactions associated with photochemical smog (ozone), the NO_2 concentration in a particular geographical area may not be representative of the local NO_X emission sources.

Inhalation is the most common form of exposure to NO_2, with the principal site of toxicity being the lower respiratory tract. The severity of adverse health effects depends primarily on the concentration of NO_2 inhaled rather than the duration of exposure. An individual may experience a variety of acute symptoms, including coughing, difficulty with breathing, vomiting, headache, and eye irritation, during or shortly after exposure. After approximately 4 to 12 hours of exposure, an individual may experience chemical pneumonitis or pulmonary edema, with breathing abnormalities, cough, cyanosis, chest pain, and rapid heartbeat. Severe, symptomatic NO_2 intoxication after acute exposure has been linked on occasion with prolonged respiratory impairment, including symptoms such as chronic bronchitis and decreased lung function.

Sulfur Dioxide

Sulfur dioxide (SO_2) is produced by stationary sources like coal and oil combustion, steel mills, refineries, and pulp and paper mills. The major adverse health effects associated with SO_2 exposure relate to the upper respiratory tract. SO_2 is a respiratory irritant, with constriction of the bronchioles occurring with inhalation of SO_2 at 5 ppm or more. On contact with the moist mucous membranes, SO_2 produces sulfurous acid, which is a direct irritant. Concentration rather than duration of the exposure is the most important determinant of respiratory effects. Exposure to high SO_2 concentrations may result in edema of the lungs or glottis and respiratory paralysis (USEPA 2018).

Particulate Matter

Particulate matter (PM) is a mixture of solid particles and liquid droplets found in air. PM that is small enough to be inhaled has a diameter of 10 microns or less is referred to as PM_{10}. PM_{10} consists of particulate matter emitted directly into the air, such as fugitive dust, soot, and smoke from mobile and stationary sources, construction operations, fires, natural windblown dust, and can be formed in the atmosphere by condensation or transformation of SO_2 and ROG (USEPA 2018). $PM_{2.5}$ includes a subgroup of finer particles that have a diameter of 2.5 microns or less.

Generally, adverse health effects associated with PM_{10} may result from both short-term and long-term exposure to elevated concentrations, and may include breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular diseases, alterations to the immune system, carcinogenesis, and premature death (USEPA 2018). The adverse health effects associated with PM_{10} depend on the specific composition of the particulate matter. For example, health effects may be associated with adsorption of metals, polycyclic aromatic hydrocarbons, and other toxic substances onto fine particulate matter (referred to as the "piggybacking effect"), or with fine dust particles of silica or asbestos. $PM_{2.5}$ poses an increased health risk when compared to PM_{10} because the particles can deposit deep in the lungs and are more likely to contain substances that are particularly harmful to human health.

Lead

Lead is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions historically have been mobile and industrial sources. Due to the phase-out of leaded gasoline, as discussed in detail in this section, metal processing currently is the primary source of lead emissions. The highest levels of lead in the atmosphere generally are found near lead smelters. Other stationary sources include waste incinerators, utilities, and lead-acid battery manufacturers.

Twenty years ago, mobile sources (e.g., motor vehicles using leaded fuel) were the main contributor to ambient lead concentrations in the air. In the early 1970s, the United States Environmental Protection Agency (USEPA) established national regulations to gradually reduce the lead content in gasoline. In 1975, unleaded gasoline was introduced for motor vehicles equipped with catalytic converters. USEPA banned the use of leaded gasoline in highway vehicles in December 1995 (USEPA 2018).

Due to USEPA's regulatory efforts to remove lead from gasoline, emissions of lead from the transportation sector declined by 95 percent between 1980 and 1999, and levels of lead in the air decreased by 94 percent between 1980 and 1999. Transportation sources, primarily airplanes, now contribute to only 13 percent of lead emissions. A recent National Health and Nutrition Examination Survey reported a 78 percent decrease in the levels of lead in people's blood between 1976 and 1991. This dramatic decline can be attributed to the move from leaded to unleaded gasoline (USEPA 2018).

Similarly, lead emissions and ambient lead concentrations have decreased dramatically in California over the past 25 years. The phase-out of lead in gasoline began during the 1970s, and subsequent California Air Resources Board (CARB) regulations have eliminated virtually all lead from gasoline now sold in California. All areas of the state currently are designated as attainment for state lead standard (USEPA does not designate areas for the national lead standard). Although the ambient lead standards are no longer violated, lead emissions from stationary sources still pose "hot spot" problems in some areas. Therefore, CARB has identified lead as a toxic air contaminant (TAC).

3.9.2.3 Monitoring-Station Data and Attainment-Area Designations

Concentrations of criteria air pollutants are measured at an ambient air quality monitoring station in Yreka (located at 525 South Foothill Drive), which is the closest monitoring station to the Proposed Project in the Northeast Plateau Air Basin (NPAB). This monitoring station is centrally located in Siskiyou County and is the main station that measures criteria air pollutants in the County. As such, this monitoring station is considered representative of air quality in Siskiyou County. The most recent three years of available information on air quality data is provided in Table 3.9-1. As noted below, carbon monoxide (CO) and nitrogen dioxide (NOx) are not measured at the Yreka monitoring station. Data for CO and NOx in Table 3.9-1 was obtained from the closest monitoring station to Yreka, which is the Eureka-Jacobs monitoring station in Eureka, CA. The most recent data available for CO from the Eureka-Jacobs monitoring station is 2012-2014.

Table 3.9-1. Summary of Annual Ambient Air Quality Data (2014–2016).

	2014	2015	2016
Ozone			
Maximum concentration (1-hour/8-hour average, ppm)	0.082/0.065	0.076/0.066	0.092/0.068
Number of days state standard exceeded (1-hour)	0	0	0
Number of days 8-hour standard exceeded (National/California)	0/0	0/0	0/0
Carbon Monoxide[1]			
Maximum concentration (8-hour, ppm)	0.70	*	*
Number of days state standard exceeded	0	0	0
Number of days national standard exceeded	0	0	0
Nitrogen Dioxide [1]			
Maximum concentration (1-hour, ppb)	26.9	35.9	35.1
Number of days state standard exceeded	0	0	0
Annual average (ppm)	2	3	2
Fine Particulate Matter ($PM_{2.5}$)			
Maximum concentration (ug/m^3) (National/California)	71.9/71.9	51.0/51.0	25.1/25.1
Number of days national standard exceeded (estimated/measured)	*/2	*/2	0.0/0
Annual average (ug/m^3) (National/California)	*/*	*/*	4.9/*
Respirable Particulate Matter (PM_{10})			
Maximum concentration (ug/m^3) (National/California)	90.6/82.9	65.5/59.6	*/*
Number of days state standard exceeded (estimated/measured)	*/3	6.1/1	*/0
Number of days national standard exceeded (estimated/measured)	0.0/0	0.0/0	*/0
Annual average (ug/m^3) (California)	*	12.9	*

Source: CARB 2017

Notes:

ug/m^3 = micrograms per cubic meter

$PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter

PM_{10} = particulate matter less than or equal to 10 microns in diameter

ppm = parts per million

ppb = parts per billion

* Insufficient data available to determine the value.

[1] Carbon monoxide and nitrogen dioxide are not measured at any monitoring station in the NPAB. The data shown in the table were obtained from the Eureka-Jacobs monitoring station in Eureka, California, which is approximately 135 miles southwest of the Proposed Project. The most current data available for carbon monoxide from this monitoring station were for the years 2012–2014.

Both CARB and USEPA use this type of monitoring data to designate areas according to their attainment status for criteria air pollutants. The purpose of these designations is to identify areas with air quality problems, and initiate planning efforts for improvement. The three basic designation categories are “non-attainment,” “attainment,” and “unclassified.” The attainment designation means that an area meets the national or state ambient air quality standards for a given criteria air pollutant. The non-attainment designation means that an area exceeds the national or state ambient air quality standards for a given criteria air pollutant. The unclassified designation is used in an area that cannot be classified on the basis of available information as meeting or not meeting the standards. In addition, the California designations include a subcategory of the non-attainment designation, called “non-attainment-transitional.” The non-attainment-transitional designation is given to non-attainment areas that are progressing and nearing attainment.

Table 3.9-2 shows the attainment status of Siskiyou County with respect to national ambient air quality standards (NAAQS) (CARB 2016b) and California ambient air quality standards (CAAQS) (CARB 2016b). As indicated in Table 3.9-2, Siskiyou County is designated as attainment or unclassified for all federal and state ambient air quality standards.

Table 3.9-2. Attainment Status Summary, Siskiyou County.

Criteria Pollutant	Federal Designation	State Designation
Ozone (O_3) (1-hour)	(no federal standard)	Attainment
Ozone (O_3) (8-hour)	Unclassified/Attainment*	Attainment
Nitrogen Dioxide (NO_2)	Unclassified/Attainment*	Attainment
Sulfur Dioxide (SO_2)	Unclassified*	Attainment
Carbon Monoxide (CO)	Unclassified/Attainment*	Unclassified*
Particulates (as PM_{10})	Unclassified*	Attainment
Particulates (as $PM_{2.5}$)	Unclassified/Attainment*	Attainment
Lead (Pb)	Unclassified/Attainment*	Attainment
Sulfates (as SO_4)	(no federal standard)	Attainment
Hydrogen Sulfide (H_2S)	(no federal standard)	Unclassified*
Vinyl Chloride (C_2H_3Cl)	(no federal standard)	n/d
Visibility Reducing Particles	(no federal standard)	Unclassified*

Source: CARB 2015a
Notes:
* At the time of designation, if the available data does not support a designation of attainment or non-attainment, the area is designated as unclassified.
n/d—no data/information available

Appendix N provides a summary of the existing emission sources and monitoring data, detailed emission calculation methodologies, and detailed emission inventories.

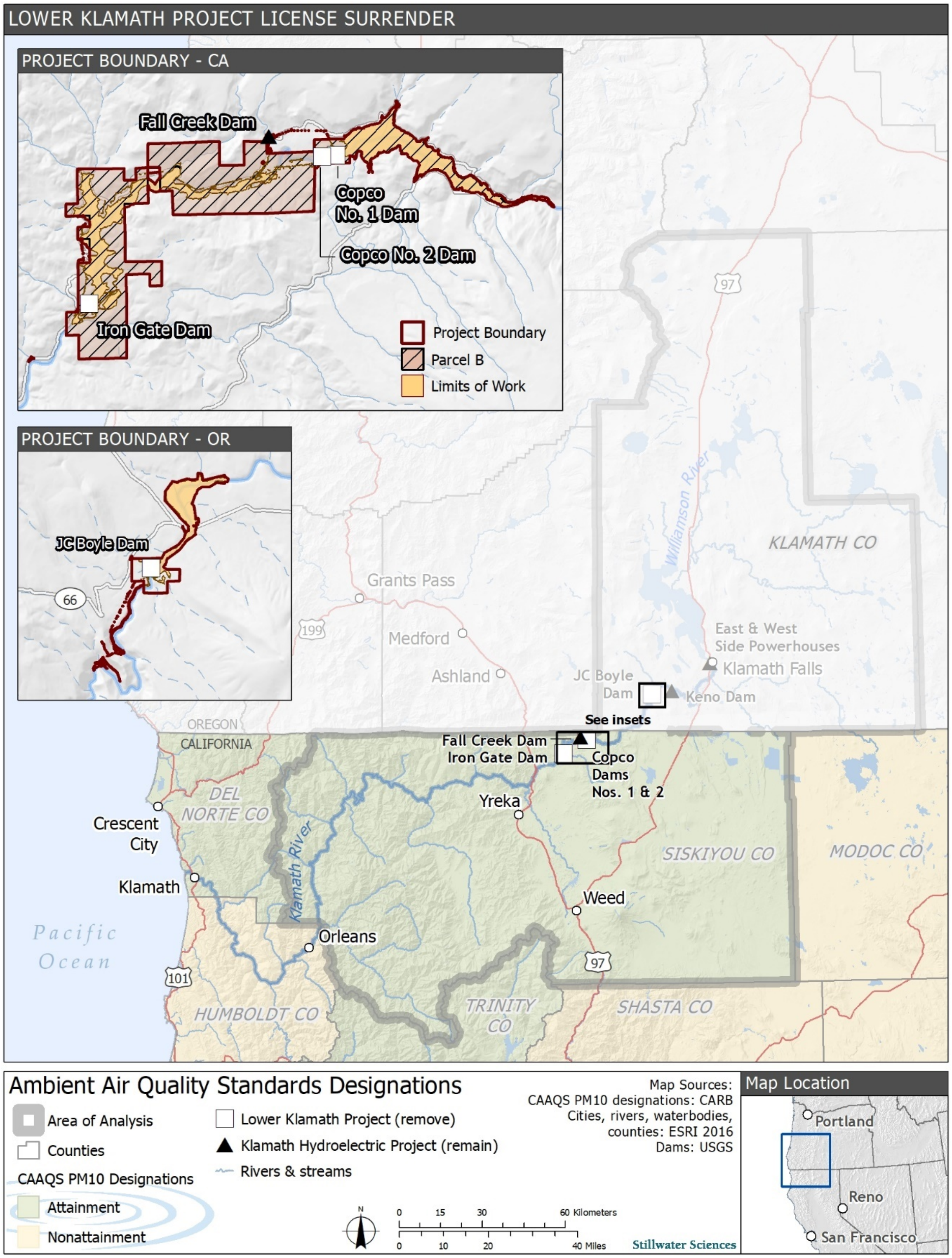

Figure 3.9-2. Particulate Matter (PM_{10}) California Ambient Air Quality Standards (CAAQS) Designations.

3.9.2.4 Air Quality Conditions

Sources of criteria air pollutant emissions in Siskiyou County include stationary, area-wide, and mobile sources. These sources are summarized in Table 3.9-3. According to Siskiyou County's emissions inventory, stationary sources provide a relatively small contribution to total emissions. Area-wide sources, which include emissions spread over a wide area such as consumer products, fire places, road dust, and farming operations, account for approximately 94 percent and 78 percent of the county's total PM_{10} and $PM_{2.5}$ emissions respectively, and 66 percent of total ROG emissions. Mobile sources are the largest contributor to the estimated annual average air pollutant levels of NO_X, accounting for approximately 94 percent of the total emissions. Mobile sources also account for approximately 27 percent of the total ROG emissions for the county.

Table 3.9-3. Summary of 2015 Estimated Emissions Inventory for Siskiyou County.

Source Type/Category	Estimated Annual Average Emissions (Tons per Day)			
	ROG	NO_X	PM_{10}	$PM_{2.5}$
Stationary Sources				
Fuel Combustion	0.09	0.33	0.25	0.24
Waste Disposal	0.00	0.00	0.00	0.00
Cleaning and Surface Coating	0.19	-	-	-
Petroleum Production and Marketing	0.40	-	-	-
Industrial Processes	0.14	-	0.35	0.15
Subtotal (Stationary Sources)	**0.82**	**0.33**	**0.61**	**0.39**
Area wide Sources				
Solvent Evaporation	4.63	-	-	-
Miscellaneous Processes	3.89	0.70	17.05	4.80
Subtotal (Area-wide Sources)	**8.52**	**0.70**	**17.05**	**4.80**
Mobile Sources				
On-Road Motor Vehicles	1.74	4.96	0.24	0.13
Other Mobile Sources	0.90	2.40	0.11	0.10
Subtotal (Mobile Sources)	**2.64**	**7.36**	**0.36**	**0.23**
Grand Total for Siskiyou County	**11.98**	**8.39**	**18.01**	**5.42**

Source: CARB 2015b
Notes: "-" = less than 0.1 ton per day
Totals shown in this table are rounded, and therefore may not appear to add exactly.

3.9.2.5 Local Emission Sources

Land uses surrounding the Limits of Work for the Proposed Project include mainly open space and recreational land. Sources of criteria air pollutants are primarily area-wide and mobile sources. Mobile sources include road motor vehicles, such as trucks and passenger vehicles. Area-wide sources include road dust, farming operations, and fire places.

3.9.2.6 Air Quality—Toxic Air Contaminants

Toxic Air Contaminants (TACs) are air pollutants that may cause or contribute to an increase in mortality or serious illness or pose a hazard to human health. TACs usually are present in small quantities in the ambient air. However, in some cases, their high toxicity or health risk may pose a threat to public health even at low concentrations. Of the TACs for which data are available in California, diesel PM, benzene, 1,3-butadiene, acetaldehyde, carbon tetrachloride, hexavalent chromium, para-dichlorobenzene, formaldehyde, methylene chloride, and perchloroethylene pose the greatest ambient risks.

According to CARB, the majority of the estimated health risk from TACs can be attributed to relatively few compounds, the most important being particulate matter from diesel-fueled engines (diesel PM) (CARB 2013). Diesel PM differs from other TACs in that it is not a single substance but rather a complex mixture of hundreds of substances. Although diesel PM is emitted by diesel-fueled, internal combustion engines, the composition of the emissions varies depending on engine type, operating conditions, fuel composition, lubricating oil, and whether an emission control system is present. Other sources of particulate matter emissions are discussed in Section 3.9.2.2 *Criteria Air Pollutants*.

Statewide, diesel PM emissions account for approximately two percent of the annual average for on-road emissions, while other diesel PM emissions from off-road mobile sources (e.g., construction and agricultural equipment) account for an additional three percent (CARB 2013). Statewide diesel PM emissions decreased approximately 37 percent from year 2000 to 2010, primarily from implementation of more stringent federal emission standards and cleaner burning diesel fuel (CARB 2013). CARB anticipates that diesel PM emissions from on-road and other mobile sources (e.g., construction and agricultural equipment) will continue to decrease into 2035. This decrease would also be attributed to more stringent emissions standards and the introduction of cleaner burning diesel fuel.

3.9.2.7 Sensitive Land Uses

As noted above, high concentrations of criteria air pollutants and toxic air contaminants can result in adverse health effects to humans. Some population groups are considered more sensitive to air pollution and odors than others; in particular, children, elderly, and acutely ill and chronically ill persons, especially those with cardio-respiratory diseases, such as asthma and bronchitis. Sensitive land uses are facilities that generally house more sensitive people (e.g., schools, hospitals, nursing homes, residences, etc.).

The areas surrounding Iron Gate Dam, Copco No. 1 Dam, and Copco No. 2 Dam are sparsely populated with few sensitive land uses. The nearest sensitive land uses are recreational facilities, located along the Copco No. 1 Reservoir and Iron Gate Reservoir, along with hiking trails around the Fall Creek development (see Section 3.20 *Recreation* for more details). The next closest sensitive land uses include scattered residences that are located along the Klamath River. The closest homes to construction sites are located over 2,000 feet from Copco No. 1 Dam, over 3,500 feet from Copco No. 2 Dam, and over 4,000 feet from Iron Gate Dam. There are also several modular homes located at Copco Village that are currently occupied by PacifiCorp staff. These homes are located within the Limits of Work and range from 850 feet to 2,200 feet west of the Copco No. 2 Powerhouse (Figure 2.7-2). Prior to the beginning of dam deconstruction activities, these homes would be vacated. The nearest licensed daycare providers and hospitals are located in Yreka, approximately 15 miles southwest of Iron Gate Dam. The nearest schools are more than 5 miles from Iron Gate Dam (Bogus Elementary is approximately 5.3 miles; Willow Creek Elementary School is approximately 5.5 miles; Hornbrook Elementary School is more than 6 miles).

3.9.2.8 Characteristics of Odors

Odors generally are regarded as a nuisance rather than a health hazard. However, manifestations of a person's reaction to foul odors can range from psychological (e.g., anger or anxiety) to physiological (e.g., circulatory and respiratory effects, nausea, vomiting, or headache).

The ability to detect odors varies considerably among the population and the odor interpretation is subjective. Some individuals have the ability to smell small quantities of specific substances. Others may not have the same sensitivity but may have sensitivities to odors of other substances. In addition, people may have different reactions to the same odor. An odor that is offensive to one person (e.g., from a fast food restaurant) may be perfectly acceptable to another. Unfamiliar odors are detected more easily than familiar odors and are more likely to be offensive.

Quality and intensity are two properties present in any odor. The quality of an odor indicates the nature of the smell experience. For instance, if a person describes an odor as flowery or sweet, then the person is describing the quality of the odor. Intensity refers to the strength of the odor. Odor intensity depends on the odorant concentration in the air. When an odorous sample is progressively diluted, the odorant concentration decreases. As this occurs, the intensity of the odor weakens and eventually becomes so low that detection or recognition of the odor is difficult. At some point during dilution, the concentration of the odorant reaches a detection threshold. An odorant concentration below the detection threshold means that the concentration in the air is not detectable by the average person (Siskiyou County 2017).

Odors currently present on a periodic basis in areas within and adjacent to the Proposed Project Limits of Work are generated from livestock, agricultural crop production, wood burning, wildfires, on-site wastewater treatment systems, and algal blooms in Iron Gate Reservoir and Copco No. 1 Reservoir.

3.9.3 Significance Criteria

Criteria for determining significant impacts on air quality are based upon Appendix G the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and best professional judgement. Effects on air quality are considered significant if the Proposed Project would result in one or more of the following conditions or situations:

1. Conflict with or obstruct implementation of the California Regional Haze Plan.
2. Exceed the Siskiyou County Air Pollution Control District emissions thresholds in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants).
3. Result in a cumulatively considerable net increase of any criteria pollutant for which the Siskiyou County Air Pollution Control District is in non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).
4. Expose sensitive receptors to substantial toxic air contaminant concentrations during project construction.
5. Create objectionable odors affecting a substantial number of people during project construction.

For areas that are designated as non-attainment for criteria air pollutants, some of the air districts in California have developed air quality plans that contain measures designed to reduce the sources of these air pollutants. As noted in Table 3.9-2 (Attainment Status Summary, Siskiyou County), Siskiyou County is designated as attainment or unclassified for all federal and state ambient air quality standards. As such, the Siskiyou County Air Pollution Control District has not developed any air quality plans relevant to the Proposed Project. As noted above, the construction emissions in Oregon are only being considered to the extent that these emissions would influence air quality in Siskiyou County, California. As such, consistency with air quality plans relevant to Klamath County, Oregon are not considered in this section.

To protect visibility in Class 1 federal lands (e.g., national parks and scenic areas), the USEPA adopted the Regional Haze Rule in 1999. The Rule lays out specific requirements to ensure improvements in the anthropogenic components of visibility at 156 of the largest national parks and wilderness areas across the United States. The vast majority of these areas are in the West (118), with 29 in California, including such national treasures as Yosemite and Sequoia National Parks. Good visibility is essential to the enjoyment of national parks and scenic areas. Across the United States, regional haze has decreased the visual range in these pristine areas from 140 miles to 35–90 miles in the West, and from 90 miles to 15–25 miles in the East. This haze is composed of small particles that absorb and scatter light, affecting the clarity and color of what humans see in a vista. The pollutants (also called *haze species*) that create haze are measurable as sulfates, nitrates, organic carbon, elemental carbon, fine soil, sea salt, and coarse mass. Anthropogenic sources of haze include industry, motor vehicles, agricultural and forestry burning, and dust from soils disturbed by human activities. Pollutants from these sources, in concentrations much lower than those which affect public health, can impair visibility anywhere.

To comply with the Regional Haze Rule, CARB developed a Regional Haze Plan (CARB 2009) which sets out a long-term path towards attaining improved visibility in national parks and other scenic areas, with the goal of achieving visibility which reflects natural conditions by year 2064. An air quality impact would be significant if the construction emissions from the Proposed Project would substantially conflict with or obstruct implementation of the Regional Haze Plan.

Siskiyou County is in attainment or unclassified for all criteria air pollutants and the Siskiyou County Air Pollution Control District (SCAPCD) has not adopted thresholds of significance for conducting an air quality analysis under CEQA. However, the SCAPCD Rule 6.1 (Construction Permit Standards for Criteria Pollutants) contains thresholds for operational emissions from new stationary sources (CARB 2016a). Criteria air pollutants from the operation of stationary sources are considered significant if they exceed the following thresholds.

- 250 pounds per day for NO_x, volatile organic compounds (VOC), PM_{10}, $PM_{2.5}$, sulfur oxides (SO_x)
- 2,500 pounds per day for CO

Since the project proposes construction activity related to the decommissioning of the Lower Klamath Project facilities that would be completed at the end of 2021, it does not include long-term operational emissions. Unlike operational emissions, construction emissions do not occur continuously over the lifetime of a project. Rather, construction emissions are temporary emissions that are spread out over the construction period. Therefore, the application of the SCAPCD stationary source operational emissions significance threshold for construction emissions from the Proposed Project is conservative because these emissions are limited in duration. As such, an air quality standard would be violated, and a significant air quality impact would result, if the construction emissions from the Proposed Project exceed the thresholds in SCAPCD Rule 6.1.

An air quality impact would be significant if project construction would expose sensitive receptors to substantial pollutant concentrations. As noted above, population groups including children, elderly, and acutely ill and chronically ill persons, are considered more sensitive to air pollution than others. Sensitive land uses are facilities that generally house more sensitive people (e.g., schools, hospitals, nursing homes, residences, etc.). Sensitive receptors within a quarter-mile of construction activities would be at the greatest risk for exposure to fugitive dust and heavy equipment emission diesel exhaust during construction. According to the USEPA, the majority of fugitive dust generally settles out of the atmosphere within 300 feet of the source, with larger particles traveling less distance and smaller particles traveling a longer distance (USEPA 1995). According to the CARB, concentrations of mobile-source diesel particulate matter emissions are typically reduced by 70 percent at a distance of approximately 500 feet (CARB 2005).

There are several sources of odors that could result from the Proposed Project including odors from exposed sediments and odors from construction equipment emissions. These potential sources of odors are discussed below along with a determination of whether substantial numbers of people could be impacted by these sources of odors.

3.9.4 Impact Analysis Approach

Within the Area of Analysis, potential air quality impacts due to construction activities related to the removal of the Lower Klamath Project facilities were quantitatively assessed for Siskiyou County, California and Klamath County, Oregon. The quantitative assessment focused on these counties because that is where direct air quality impacts from construction activity would occur. Construction emissions estimates were developed for dam and powerhouse deconstruction, restoration activities, the relocation and demolition of recreation facilities, and the Yreka supply pipeline relocation. As noted above, the construction emissions in Oregon are only being considered to the extent that these emissions would influence air quality in Siskiyou County, California.

No changes in operational sources are part of the Proposed Project; therefore, this analysis considers only construction-related air quality impacts. Operational emissions for the reduced operation of Iron Gate Fish Hatchery combined with the re-instated operation of Fall Creek Hatchery were assumed to be the same as existing operation conditions at Iron Gate Hatchery for eight years following dam removal. This is due to the fact that the existing functions at the Iron Gate Hatchery that would be eliminated as part of dam removal activities, would be replaced by the reopening and operation of the Fall Creek Hatchery and by making improvements to the Iron Gate Hatchery (Section 2.7.6 *Hatchery Operations*).

The construction emissions estimates used for this EIR (Appendix N) were developed in 2011 as part of the 2012 KHSA EIS/EIR analysis. Although there have since been modifications to the Proposed Project schedule (Table 2.7-1), the 2011 emissions modeling is still relevant as the construction-related activities and their associated emissions for the Proposed Project are materially similar to those modeled in 2011. Minor changes in proposed construction activities between the 2012 KHSA EIS/EIR analysis and the Proposed Project are primarily due to the timing associated with removing each dam (Table 2.7.1). The exceptions to this are discussed below. The Proposed Project and the data modeled as part of the 2012 KHSA EIS/EIR are compared to the thresholds noted in Section 3.9.3 *Significance Criteria* and analyzed in Section 3.9.5 *[Air Quality] Potential Impacts and Mitigation*.

As noted in Appendix N, the estimates of earthen material waste that would require on-site disposal has decreased by approximately 80,000 cubic yards under the current project proposal (Appendix B: *Definite Plan*). As such, there is the potential to generate fewer equipment engine exhaust, haul truck engine exhaust, and fugitive dust emissions during the excavation and on-site disposal of earthen materials from the dams. However, the estimates of building waste that would require off-site disposal has increased by approximately 2,600 cubic yards under the current project proposal (Appendix B: *Definite Plan*). As such, there is the potential to generate greater equipment engine exhaust, haul truck engine exhaust, and fugitive dust emissions during the demolition and off-site disposal of building waste.

The decrease in emissions from the excavation and hauling of earthen material waste would partially off-set the increase in emissions from the demolition and hauling of building waste. However, the building waste would require disposal at off-site locations that range from 22 to 28 miles (44 to 56 miles round-trip) from the dams. The earthen material waste would be disposed of at on-site locations that range from 0.25 to 4 miles (0.5 to 8 miles round-trip) from the dams. As such, it is anticipated that the emissions from dam removal activities under the current proposal (Appendix B: *Definite Plan*) would be greater than the emissions estimates calculated for the 2012 KHSA EIS/EIR. This increase would primarily be due to haul truck engine exhaust because of the hauling distance required for the off-site disposal of building waste. This issue is addressed further under Potential Impact 3.9-2.

Quantification of Criteria Air Pollutants

This EIR's air quality analysis calculated estimates of emissions for construction activities related to dam demolition, including heavy equipment use, hauling of demolition debris to landfills, and worker transportation. Appendix N describes the methodology used to develop the emissions inventories related to construction activities. The emissions estimates are derived from the following emissions models and spreadsheet calculations:

- CARB Urban Emissions model, Version 9.2.4 (fugitive dust calculations from construction equipment, cut/fill activities, and building demolition);
- CARB Emissions Factor (EMFAC) 2007 model (on-road vehicle emissions factor model for California);
- USEPA MOBILE6.2[139] (on-road vehicle emissions factor model for Oregon), as applicable;
- CARB OFFROAD2007 (off-road vehicle emissions factor model for California);
- USEPA NONROAD2008a (off-road vehicle emissions factor model for Oregon), as applicable;
- Midwest Research Institute (1996), Improvement of Specific Emission Factors (paved road dust emissions);
- Compilation of Air Pollutant Emission Factors (AP-42) (USEPA 2006).

A combination of techniques was used to estimate emissions from the restoration activities. Emissions from landing and takeoff operations associated with aerial seed application were estimated using the Federal Aviation Administration's Emissions and Dispersion Modeling System. Emissions from hydroseeding barges were estimated using the following sources:

- Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (USEPA 2000);
- AP-42, Chapter 3.3: Gasoline and Diesel Industrial Emissions (USEPA 1996);
- Title 17 California Code of Regulations, Section 93115.7: Air Toxic Control Measure for Stationary Compression Ignition Engines—Stationary Prime Diesel-Fueled Compression Ignition Engine (>50 bhp) Emission Standards;
- Title 13 California Code of Regulations, Section 2423: Exhaust Emission Standards and Test Procedures—Off-Road Compression-Ignition Engine.

Emissions from ground support equipment were estimated using the emission factors for off-road engines identified above and EMFAC for on-road motor vehicle emissions.

[139] Although the USEPA recently developed the Motor Vehicle Emission Simulator (MOVES) to replace MOBILE6.2, MOVES has only been approved for use in SIPs and Transportation Conformity (75 FR 9411) (USEPA 2010). As it has not yet been approved for project-level analyses, MOBILE6.2 was used to estimate emissions from on-road vehicles in Oregon.

The California Emissions Estimator Model (CalEEMod), Version 2011.1.1, was used to estimate exhaust emissions that would occur from grading activities associated with restoring parking lots associated with recreational facilities proposed for removal and restoration. The California Emissions Estimator Model makes general assumptions about the quantity and types of construction equipment needed to grade a site based on its size (acreage).

The Sacramento Metropolitan Air Quality Management District's Road Construction Emissions Model, Version 6.3.2 (2009), was used to estimate exhaust emission factors associated with relocation of the Yreka water supply pipeline. The Siskiyou County Air Pollution Control District does not have a comparable model to estimate emissions from linear projects like the proposed pipeline relocation action.

Appendix N contains an estimate of "uncontrolled emissions" and an estimate of emissions after implementation of mitigation measures that were proposed as part of the analysis in the 2012 KHSA EIS/EIR. These included Mitigation Measures Air Quality (AQ)-1 (Off-road construction equipment), AQ-2 (On-road construction equipment), AQ-3 (trucks used to transport materials), and AQ-4 (Dust control measures). Mitigation Measures AQ-1 through AQ-3 required off-road construction equipment and on-road construction equipment and trucks to be equipped with engines that meet certain model year emissions standards. Mitigation Measure AQ-4 required dust control measures to minimize fugitive dust emissions during construction activity. With the implementation of these mitigation measures, the 2012 KHSA EIS/EIR determined construction emissions from the Proposed Project would still result in significant and unavoidable impacts from NO_x and PM_{10}.

The current proposal for the Proposed Project lacks sufficient detail concerning construction activities and it is too speculative to determine whether the mitigation measures proposed in the 2012 KHSA EIS/EIR are feasible and enforceable. As such, the analysis in this section does not include mitigation to minimize impacts from construction emissions generated by the Proposed Project activities. Since similar minimization measures may be implemented during project construction, it is assumed that the emissions generated by the Proposed Project would fall somewhere in the range between the uncontrolled and mitigated emissions estimates contained in Appendix N.

3.9.5 Potential Impacts and Mitigation

Potential Impact 3.9-1 Conflict with or obstruct implementation of the California Regional Haze Plan.

As noted in Table 3.9-2 (Attainment Status Summary, Siskiyou County), Siskiyou County is designated as attainment or unclassified for all federal and state ambient air quality standards. As such, the Siskiyou County Air Pollution Control District has not developed any air quality plans relevant to the Proposed Project. As noted above, the construction emissions in Oregon are only being considered to the extent that these emissions would influence air quality in Siskiyou County, California. As such, consistency with air quality plans relevant to Klamath County, Oregon are not considered in this section.

In 1999, the USEPA adopted the Regional Haze Rule, which requires states to establish a series of interim goals to ensure continued progress towards improving visibility in Class 1 federal lands (e.g., national parks and other scenic areas). To comply with the

Regional Haze Rule, CARB developed a Regional Haze Plan (CARB 2009), which sets out a long-term path towards attaining improved visibility in Class 1 federal lands, with the goal of achieving visibility which reflects natural conditions by year 2064. The closest Class 1 areas near the Proposed Project include the Marble Mountain Wilderness and Lava Beds National Monument. Sources of haze in this area of northern California include, but are not limited to, rural land uses, traffic on Interstate 5, railroad freight traffic, wildfires, and natural biogenic emissions from plants (CARB 2009).

Since the Proposed Project involves construction activity related to the decommissioning of the Lower Klamath Project facilities that would be completed at the end of 2021, and the Proposed Project would not have long-term operational emissions, the potential for the project to conflict with the California Regional Haze Plan is limited. In addition, CARB has adopted regulations designed to reduce diesel emissions from off-road vehicles, which includes construction equipment that may be used for the Proposed Project.

In July 2007, ARB adopted a pioneering regulation aimed at reducing diesel and NO_x emissions from the State's estimated 180,000 off-road vehicles used in construction, mining, airport ground support and other industries. The Regional Haze Plan indicates that CARB's In-Use Off-Road Diesel Vehicle Regulation (adopted on July 26, 2007) would reduce particulate matter and NO_x emissions by 74 percent and 32 percent, respectively, from current levels. Off-road diesel vehicles (25 horsepower or greater) and most two-engine vehicles (except on-road two-engine sweepers) used for construction activities related to the Proposed Project would be required to comply with this regulation (CARB 2016c). Adhering to this CARB regulation for off-road diesel vehicles would reduce potential visibility impacts from construction activities related to the Proposed Project and provide consistency with the Regional Haze Plan.

Therefore, the proposed project would not conflict with or obstruct implementation of the California Regional Haze Plan.

Significance

No significant impact

Potential Impact 3.9-2 Exceedance of the Siskiyou County Air Pollution Control District emissions thresholds in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants).

Summary

Table 3.9-4 summarizes the uncontrolled emissions associated with the Proposed Project activities including dam and powerhouse deconstruction, restoration activities, and the relocation and demolition of recreational facilities. Since these project activities have the potential to overlap, their daily emissions are combined and compared to emissions thresholds in the SCAPCD's Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants). Since the Yreka water pipeline relocation would occur prior to initiating drawdown of the Iron Gate Reservoir, the construction emissions from this project activity is analyzed separately.

The daily emissions estimates in Table 3.9-4 also includes construction activity related to the removal of J.C. Boyle Dam in Oregon. Due to the potential for the emissions generated from construction activity in Oregon to have air quality impacts in Siskiyou County, California, the emissions from construction activity in Oregon are conservatively added to the emissions from construction activity in California and compared to the SCAPCD's significance thresholds.

Table 3.9-4. Uncontrolled Emissions Inventories for the Proposed Project.

Phase	Peak Daily Emissions (pounds per day)[1]					
	VOC	**CO**	**NO_x**	**SO_2**	**PM_{10}**	**$PM_{2.5}$[2]**
Dam and Powerhouse Deconstruction	131	584	650	9	503	248
Restoration Activities	19	62	168	20	3	3
Recreation Facilities	12	77	85	0	17	7
Maximum Daily	162	723	**903**	29	**523**	**258**
Significance Criterion[2]	250	2,500	250	250	250	250

Source: Appendix N
Notes:
[1] Values shown in **bold** exceed the Siskiyou County Air Pollution Control District's (SCAPCD) thresholds of significance in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants).
Key:
VOC = volatile organic compounds
CO = carbon monoxide
NO_x = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

As shown in Table 3.9-4, total daily emissions from the Proposed Project are estimated to exceed the SCAPCD's significance thresholds for NO_x, PM_{10}, and $PM_{2.5}$. As such, the construction emissions from the Proposed Project would be significant.

As discussed above in Section 3.9.4 *Impact Analysis Approach*, it is anticipated that the emissions from dam removal activities under the current proposal (Appendix B: *Definite Plan*) would be greater than the emissions estimates calculated for the 2012 KHSA EIS/EIR. This increase would primarily be due to haul truck engine exhaust because of the hauling distance required for the off-site disposal of building waste. As such, it is anticipated that these additional emissions would contribute to the finding of significant impacts for the emissions of NOx, PM_{10}, and $PM_{2.5}$ from the Proposed Project. It is not anticipated that these additional emissions would cause the Proposed Project to exceed the significance thresholds for VOC, CO, or SOx for the following reasons: (1) the emissions of these criteria air pollutants from the Proposed Project are well below the SCAPCD's significance thresholds (Table 3.9-4); and (2) the hauling of waste from dam removal activities only constitutes a small portion of the emissions of these criteria air pollutants (Appendix N).

As discussed above, mitigation measures were included for the Proposed Project as part of the analysis in the 2012 KHSA EIS/EIR. The mitigation measures required on and off-road construction equipment and trucks to be equipped with engines that meet certain model year emissions standards and various dust control measures. With the implementation of these mitigation measures, the 2012 KHSA EIS/EIR determined construction emissions from the Proposed Project would still result in significant and unavoidable impacts from NO_x and PM_{10}.

As noted above, the current proposal for the Proposed Project lacks sufficient detail concerning construction activities and it is too speculative to determine whether the mitigation measures proposed in the 2012 KHSA EIS/EIR are feasible and enforceable. As such, the analysis in this section does not include mitigation to minimize impacts from construction emissions generated by the Proposed Project activities. Since similar minimization measures may be implemented during project construction, it is assumed that the emissions generated by the Proposed Project would fall somewhere in the range between the uncontrolled and mitigated emissions estimates contained in Appendix N. Due to this uncertainty, the emissions of NOx, PM_{10}, and $PM_{2.5}$ from the Proposed Project are found to be significant and unavoidable.

The discussion below provides more detailed information about the emissions from the various project activities.

Dam and Powerhouse Deconstruction

Vehicle exhaust and fugitive dust emissions from dam removal activities would generate emissions of VOC, NO_x, CO, SO_2, PM_{10}, and $PM_{2.5}$ during the dam deconstruction period. The emission sources would include exhaust emissions from off-road construction equipment, on-road trucks, construction worker employee commuting vehicles, fugitive dust emissions from unpaved roads, blasting activities, and general earth-moving activities. Activities that could generate fugitive dust include on-site operation of construction equipment and removal and placement of excavated materials (cut/fill activities).

Predicted uncontrolled peak daily emission rates for VOC, NO_x, CO, SO_2, PM_{10}, and $PM_{2.5}$ for the Proposed Project are summarized in Table 3.9-5. This analysis uses the conservative assumption that the peak day of construction could occur at the same time for each dam; therefore, the peak daily emissions are additive.

Table 3.9-5. Uncontrolled Emissions Inventories for Dam and Powerhouse Deconstruction**.**

Location	Peak Daily Emissions (pounds per day)[1]					
	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$ [2]
Iron Gate	67	272	**348**	2	210	50
Copco No. 1	27	176	129	1	174	165
Copco No. 2	22	83	113	1	17	6
J.C. Boyle	15	54	60	5	103	27
Grand Total	131	584	**650**	9	**503**	248
California Total[3]	116	531	**590**	4	**401**	221
Oregon Total	15	54	60	5	103	27
Significance Criterion[1]	250	2,500	250	250	250	250

Source: Appendix N

Notes:

1 Values shown in **bold** exceed the Siskiyou County Air Pollution Control District's (SCAPCD) thresholds of significance in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants).

2 Where emission factors were only provided for PM_{10}, appropriate PM size profiles were used to estimate $PM_{2.5}$ emissions.

3 Appendix N - California total includes emissions for activities at Iron Gate Dam, Copco No. 1 Dam, and Copco No. 2 Dam.

As Table 3.9-5 shows, emissions from deconstruction of the dams would exceed the significance criteria for NOx and PM_{10}. The greatest source of NO_x emissions from each of the dams would be off-road construction equipment, followed by on-road trucks, and then employee commuting vehicles. The major sources of PM_{10} emissions would be fugitive dust from unpaved roads and then cut/fill activities. As indicated in Table 3.9-4, deconstruction of the dams would produce the majority of construction emissions that would occur from the Proposed Project.

Cofferdams would be constructed during deconstruction activities from concrete rubble, rock, and earthen materials that would come from the dam removal activities, as possible. As the cofferdams would be constructed from materials salvaged from the dam demolition activities, emissions associated with cofferdam construction would already be included in the emissions inventory. Additional emissions could occur when the cofferdams are later demolished. Due to the limited size of these structures and the fact that much of the material used to construct the coffer dams would be disposed of in close proximity to the dam sites, it is not anticipated that the additional emissions from this activity would result in a change to the significance determinations.

Following drawdown of the reservoirs and prior to the establishment of ground vegetation from reseeding, there is the potential for windblown dust to be generated from the exposed sediment deposits remaining in the reservoirs. Once reseeding occurs, it typically takes a minimum of four weeks for vegetation to be established to reduce the potential for windblown dust. Considering that reservoir drawdown would occur in the winter months (January to March), it is anticipated that the seasonally wet conditions would substantially reduce the potential for windblown dust until the establishment of vegetation. However, there is the potential for short-term impacts from windblown dust not accounted for in the particulate matter emission estimates in Table 3.9-5 and Appendix N, Table M-19. As such, this additional source of particulate matter emissions would contribute to the finding of significant and unavoidable impacts for particulate matter emissions from the Proposed Project.

Restoration Activities

Restoration actions included in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) could result in short-term increases in criteria pollutant emissions from vehicles exhaust and fugitive dust from the use of helicopters or other small aircraft, trucks, and barges. Following drawdown of the reservoirs, revegetation efforts would be initiated to support establishment of native wetland, riparian, and upland species on newly exposed riverbank sediment and surrounding areas. Additional fall seeding may be necessary to supplement areas where spring hydroseeding was unsuccessful (Appendix B: *Definite Plan*).

Emissions from ground support equipment were estimated using the emission factors for off-road engines identified above and EMFAC model for on-road motor vehicle emissions. The majority of peak daily emissions that would be generated by the restoration activities would occur from the use of barges or aircraft for reseeding during and following reservoir drawdown. As the use of barges would cease when reservoir levels become too low (by March of dam removal year 2), there would not be an overlap between the use of the barges and the peak construction activities related to dam removal (May through September of dam removal year 2) (Table 2.7-1). Overlap that could occur between the restoration activities and peak construction activities related to dam removal, would include the use of ground and aerial equipment for reseeding (Table 3.9-4). Table 3.9-6 summarizes emissions from restoration activities.

Table 3.9-6. Uncontrolled Emissions from Restoration Activities .

Phase	Peak Daily Emissions (pounds per day)					
	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$[2]
Ground Equipment	3	8	15	2	0	0
Barges	16	54	153	18	3	3
Air craft	15	39	3	1	0	0
Maximum Daily[1]	19	62	168	20	3	3

Source: Appendix N
Notes:
[1] Barge and aerial application would not happen simultaneously; therefore, maximum daily emissions summarizes the peak day that consists of ground equipment and barges operating at the same time.

Recreation Facilities

Relocation and demolition of various recreation facilities would produce criteria pollutant emissions from vehicle exhaust and fugitive dust. The demolition of the Lower Klamath Project recreation facilities would change recreation opportunities from lake-based recreation to river-based recreation. This change would require several recreation facilities to be reconstructed or demolished. On- and off-road construction equipment would be used to complete these activities, which would occur after the dam demolition actions.

Emissions from relocation and demolition of the various recreation facilities were estimated using the CalEEMod emissions model. As the relocation and demolition of recreational facilities could occur during dam demolition, it is assumed there would be an overlap with the peak construction activities related to dam removal (Table 3.9-4). Table 3.9-7 summarizes emissions from the relocation and demolition of recreation facilities.

Table 3.9-7. Uncontrolled Emissions from Relocation and Demolition of Recreation Facilities.

Location	Peak Daily Emissions (pounds per day)					
	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$[2]
J.C. Boyle	4	32	31	0	4	1
Copco No. 1 Reservoir	2	13	16	0	4	2
Iron Gate Reservoir	6	32	38	0	9	4
Total Emissions	12	77	85	0	17	7

Source: Appendix N

City of Yreka Water Supply Pipeline Relocation

Construction of a new water supply pipeline for Yreka would produce criteria pollutant emissions from vehicle exhaust and fugitive dust. On- and off-road construction equipment would be used to complete the relocation and construction of the Yreka water supply pipeline. Construction of the pipeline would occur prior to initiating drawdown of the Iron Gate Reservoir. It is estimated the replacement of the water supply pipeline would last approximately one month. As such, emissions from this project activity would not overlap with peak daily emissions due to dam removal construction activities (Table 2.7-1) (Section 2.7.7 *City of Yreka Water Supply Pipeline Relocation*). The Sacramento Metropolitan Air Quality Management District's Road Construction Emissions Model (2009) was used to estimate emissions associated with grubbing/land clearing, grading/excavation, and other phases. Table 3.9-8 summarizes emissions from replacement of the Yreka water supply pipeline.

Table 3.9-8. Uncontrolled Emissions from Construction of the Yreka Water Supply Pipeline.

Phase	Peak Daily Emissions (pounds per day)					
	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$
Grubbing/Land Clearing	2.3	9.3	16.4	--	10.1	2.6
Grading/Excavation	2.8	16.5	18.4	--	10.3	2.7
Drainage/Utilities/Sub-Grade	2.2	11.3	14.4	--	10.2	2.6
Maximum	2.8	16.5	18.4	--	10.3	2.7
Significance Criterion	250	2,500	250	250	250	250

Source: Appendix N

As shown in Table 3.9-8, emissions from replacement of the Yreka water supply pipeline would not exceed the SCAPCD's significance thresholds. Therefore, emissions from construction of the Yreka water supply pipeline would be less than significant.

Other Project Components

Construction activities associated with implementation of the Other Project Components identified in Section 7 of the Definite Plan, would produce additional emissions from vehicle exhaust and fugitive dust. These activities include, but are not limited to, improvements to roads, bridges and culverts that would be affected by the Proposed Project, relocation or elevation of structures that would be subject to flood risk after removal of the dams, and the modification of downstream water intakes to protect them from passing sediment after removal of the dams. On- and off-road construction equipment would be used to complete the necessary construction.

Due to the limited nature of these additional project components, they are anticipated to produce minor emissions compared to the dam and powerhouse demolition activities. The emissions estimates for the relocation of the Yreka water supply pipeline are considered to be representative of the emissions that would be generated by these project components.

Most of these project components are planned to take place before or after primary construction and deconstruction associated with the Proposed Project. As such, they would not overlap with the peak construction activity related to the dam and powerhouse deconstruction, restoration activities, and the relocation and demolition of recreation facilities. However, there is the potential that some of these project components may overlap with the peak construction activity. To the extent that this occurs, the additional emissions produced by these project components would contribute to the significant and unavoidable significance determination related to emissions of NOx, PM_{10}, and $PM_{2.5}$ generated during peak construction activity.

Therefore, air quality impacts from the implementation of the other project components would be significant and unavoidable.

Significance
Significant and unavoidable impact

Potential Impact 3.9-3 Short-term cumulative increase in criteria pollutants for which the Siskiyou County Air Pollution Control District is non-attainment.
Direct air quality impacts from construction activities occurring during the Proposed Project would be limited to Siskiyou County, California, which is designated as attainment or unclassified for all federal and state ambient air quality standards (Table 3.9-2). As such, the Proposed Project would not result in a cumulatively considerable net increase of any criteria air pollutant for which Siskiyou County is non-attainment (including releasing emissions which exceed quantitative thresholds for ozone precursors).

Significance
No significant impact

Potential Impact 3.9-4 Short-term exposure of sensitive receptors to substantial toxic air contaminant concentrations.
The area surrounding Iron Gate Dam, Copco No. 1 Dam, and Copco No. 2 Dam is sparsely populated with few sensitive land uses. The nearest sensitive land uses are recreational facilities located at Copco No. 1 and Iron Gate reservoirs, along with hiking trails around the Fall Creek development (Section 3.20 *Recreation*). The next closest sensitive land uses include scattered residences that are located along the Klamath River. The closest homes to construction sites are located over 2,000 feet from Copco No. 1 Dam, over 3,500 feet from Copco No. 2 Dam, and over 4,000 feet from Iron Gate Dam. As noted above, there are also several modular homes located at Copco Village that are currently occupied by PacifiCorp staff. These homes are located within the Limits of Work and range from 850 feet to 2,200 feet west of the Copco No. 2 Powerhouse (Figure 2.7-2). Prior to the beginning of dam deconstruction activities, these homes would be vacated.

The Proposed Project has the potential to create a significant hazard to sensitive receptors (e.g., residents and recreationists) near the construction sites through exposure to substantial pollutant concentrations such as ROG, NO_X and particulate matter and/or other toxic air contaminants during construction activities. Construction activities would involve the use of a variety of gasoline or diesel-powered equipment that emits exhaust fumes. Sensitive receptors in the vicinity of the construction sites would potentially be exposed to nuisance dust and heavy equipment emission diesel exhaust during construction. The duration of exposure would be short and exhaust from construction equipment dissipates rapidly. Sensitive receptors within a quarter-mile (1,320 feet) of construction activities would be at the greatest risk for exposure to fugitive dust and diesel exhaust during construction.

Since the recreation facilities near the construction sites would be closed during dam removal activities, it is not anticipated that recreationists would be exposed to substantial pollutant concentrations during construction activity. As noted above, the closest residences are located over 2,000 feet away from the construction sites. According to the USEPA, the majority of fugitive dust generally settles out of the atmosphere within

300 feet of the source, with larger particles traveling less distance and smaller particles traveling a longer distance (USEPA 1995). According to the CARB, concentrations of mobile-source diesel particulate matter emissions are typically reduced by 70 percent at a distance of approximately 500 feet (CARB 2005). Due to the low density of residential uses in the project area, and the fact that the nearest residences are well over a quarter mile (1,320 feet) from the construction sites, it is not anticipated that sensitive receptors residing at the closest residences would be exposed to substantial toxic air contaminant concentrations during construction activities. Therefore, the exposure of sensitive receptors to pollutant concentrations during construction activity is less than significant.

Significance

No significant impact

Potential Impact 3.9-5 Short-term exposure to objectionable odors near construction sites.

The Siskiyou County Air Pollution Control District addresses odor impacts through Rule 4.2 (Nuisance Section 24243), which states "No person shall discharge from any source whatsoever, such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of persons or to the public or which endanger the comfort, repose, health or safety of any such persons or the public or which cause or have a natural tendency to cause injury or damage to business or property." Rule 4.2 does not apply to odors emanating from agricultural operations in the growing of crops or raising of fowl or animals (CARB 2016a).

The following odors could result from the Proposed Project:

- Odors from exposed sediments (including algae) in the reservoir footprints; and
- Odors from construction equipment/vehicle exhaust.

Both of these odor sources would be likely to generate minor odor impacts relative to land use types capable of generating significant odor impacts (e.g., wastewater treatment plant, sanitary landfill, petroleum refinery, rendering plant, food packaging plant) (SMAQMD 2016).

The Proposed Project would ultimately drain Iron Gate, Copco No. 1, and Copco No. 2 reservoirs and expose the underlying sediments. Because the reservoir sediment deposits contain unoxidized organic matter from algal detritus (organic content of the sediments is on average 2.7 to 5.1 percent by mass [GEC 2006]), earthy or sulfide odors (e.g., tidal marsh sediment odors at low tide), may be evident during or immediately following reservoir drawdown while the exposed sediments dry out and new vegetation is established. There is the potential that these odors could temporarily impact nearby land uses such as the closest recreational facilities and residential uses. These odor impacts have the potential to cause nearby recreationists and residents to reduce outdoor activity or take other actions to avoid detection of the odors (e.g., keep windows closed). The level of impact would be dependent on proximity to the reservoirs and wind patterns during and immediately following reservoir drawdown (i.e., winter and spring months). Within a relatively short amount of time (i.e., days to a few weeks), the sediment surfaces would oxidize as they are exposed to air and the organic compounds causing the odors would be broken down. Due to the low density of development in the vicinity of the reservoirs, the relatively low number of recreationists in the vicinity of the Lower Klamath Project reservoirs during winter and spring months) the short-term nature of the anticipated odor impacts (days to a few weeks during dam removal year 2), it is not anticipated that the Proposed Project would create objectionable odors affecting a substantial number of people and thus would not result in a significant impact.

As discussed in Section 3.20 *Recreation*, two-thirds of recreational users of the Klamath River reservoirs that were surveyed responded that the algae blooms in the reservoirs produced bad odors. Reservoir drawdown under the Proposed Project would occur during winter months (January–March) (Table 2.7-1) when intense algae blooms do not typically occur in lakes and reservoirs in general, or in the Lower Klamath Project reservoirs in particular (Section 3.2 *Water Quality* and Section 3.4 *Phytoplankton and Periphyton*). Despite a very low likelihood of occurrence, algae blooms could be present as reservoir drawdown occurs and as the water level lowers in the reservoirs, algae would settle on the exposed sediments. If this does occur, it is anticipated that the algae and underlying sediments would dry out quickly (i.e., within days to weeks), which would substantially reduce any odors generated by decaying algae. Similar to odors from the reservoir sediments, it is not anticipated that a substantial number of people would be impacted due to the low density of development in the area and the short-term nature of the odor impacts. Ultimately, the Proposed Project is anticipated to substantially reduce the annual occurrence of odors from algae blooms since this section of the Klamath River would be restored to a free-flowing condition.

During construction, there is the potential for the generation of objectionable odors in the form of construction equipment/vehicle exhaust in the immediate vicinity of the construction sites at the three dams (Copco No. 1, Copco No. 2, and Iron Gate). However, these emissions would rapidly dissipate and be diluted by the atmosphere downwind of the site. As noted above, CARB estimates that concentrations of mobile-source diesel particulate matter emissions are typically reduced by 70 percent at a distance of approximately 500 feet (CARB 2005). At this distance from the construction sites, there would also be a substantial reduction in odors generated by exhaust emissions. The nearest residences to the dam construction sites are over 2,000 feet away, which would provide adequate distance for the dissipation of odors from construction activity. Due to the low density of development in the areas within and adjacent to the Limits of Work, intervening topography and vegetation, and the rapid dissipation of odors from construction activity, it is not anticipated that these odors would impact a substantial number of people.

Significance
No significant impact

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3.10 Greenhouse Gas Emissions

This section focuses on potential greenhouse gas (GHG) and energy effects due to implementation of the Proposed Project. Section 3.9 *Air Quality* of the Lower Klamath Project EIR discusses air quality.

3.10.1 Area of Analysis

Global climate change is not confined to a particular project area and is generally accepted as the consequence of global industrialization over the last 200 years. A typical project, even a very large one, does not generate enough greenhouse gas emissions on its own to influence global climate change significantly; hence, the issue of global climate change is, by definition, a cumulative environmental impact. For this reason, the Area of Analysis for GHG emissions and energy effects includes areas within California and Oregon where construction activities related to removal of the Lower Klamath Project dam complexes would occur (Figure 3.10-1). In addition, these areas may experience impacts from GHG emissions as a result of replacing hydroelectric power produced at the Lower Klamath Project dams on an interim basis with power that may be produced from fossil fuels through other regional sources.

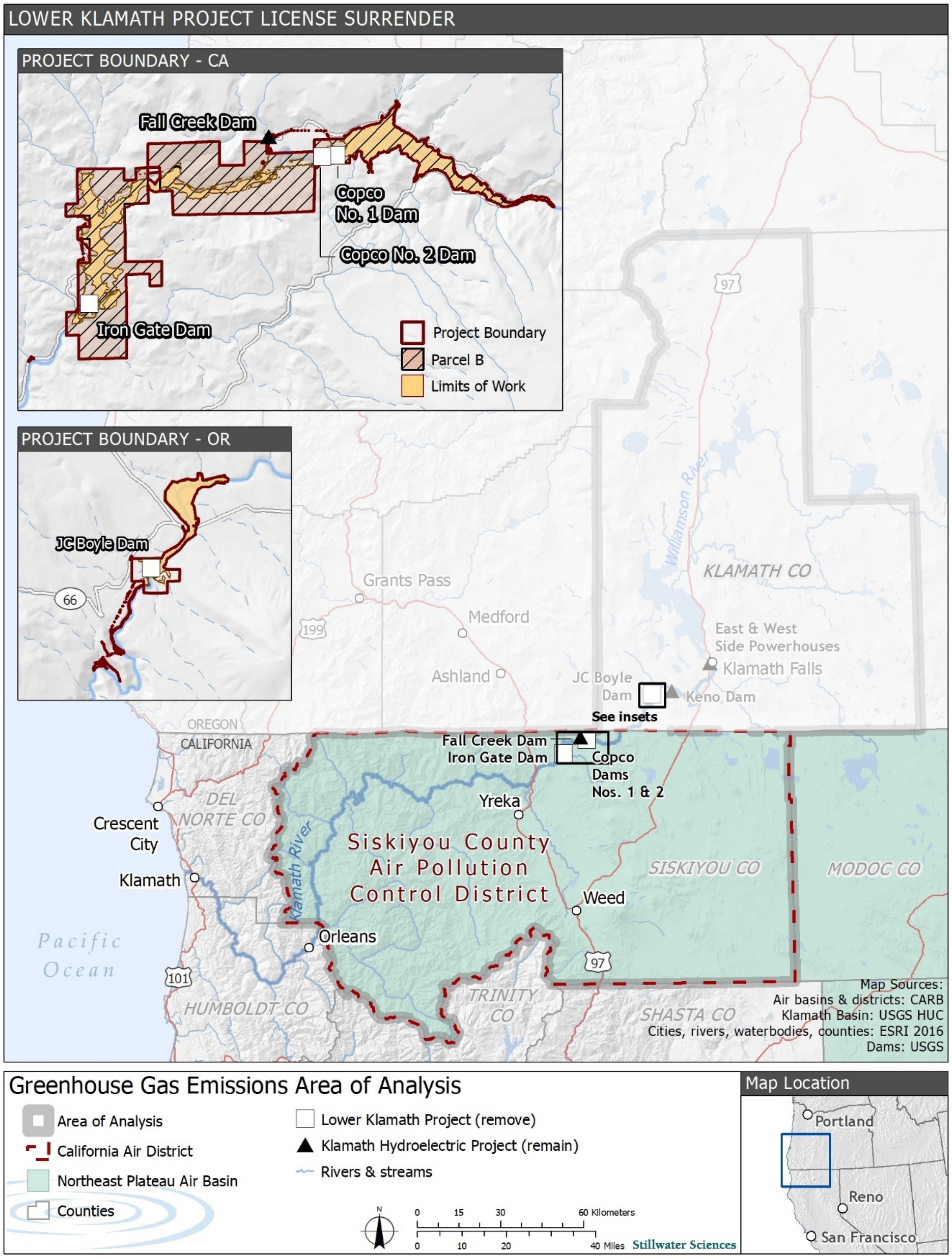

Figure 3.10-1. Area of Analysis for Greenhouse Gas Emissions.

3.10.2 Environmental Setting

3.10.2.1 Greenhouse Gas Emissions

Summary information regarding anticipated global, state, and regional effects of climate change are provided below, as well as a discussion of GHG emissions generated in California and the potential influence of the Lower Klamath Project dam complexes on GHG emissions.

Although Proposed Project-related emissions would be restricted to the Area of Analysis described above, data characterizing existing GHG emissions are only available at the state-level for California (California Air Resources Board [CARB] 2017a). As a result, the GHG environmental setting uses a larger region than that of the Area of Analysis for GHG emissions to establish existing conditions.

Global Climate Change

Radiation from the sun is the Earth's primary source of energy. As solar radiation enters the Earth's atmosphere, a portion is reflected back towards space; a portion is absorbed by the upper atmosphere; and a portion is absorbed by the Earth's surface. The radiation absorbed by the Earth heats the surface, which is then emitted as infrared radiation. As Earth has a much lower temperature than the sun, the Earth emits longer-wavelength radiation[140]. Certain gases in the Earth's atmosphere, classified as GHGs, play a critical role in determining the Earth's surface temperature. GHGs have strong absorption properties at wavelengths that are emitted by the Earth. As a result, radiation that otherwise would have escaped back into space is instead trapped, resulting in a warming of the atmosphere. This phenomenon, known as "the greenhouse effect", is responsible for maintaining a habitable climate on Earth.

Anthropogenic emissions of GHGs, leading to atmospheric levels in excess of natural ambient concentrations, are responsible for intensifying the greenhouse effect, and have led to a trend of unnatural warming of the Earth's atmosphere and oceans, with corresponding effects on global circulation patterns and climate (Stocker 2014). Prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

HFCs, PFCs, and SF_6 are considered high global warming-potential (GWP) GHGs. GWP is a concept developed to compare the ability of each GHG to trap heat in the atmosphere relative to another gas. GWP is based on several factors, including the relative effectiveness of a gas absorbing infrared radiation, and length of time that the gas remains in the atmosphere ("atmospheric lifetime"). The GWP of each gas is measured relative to CO_2, the most abundant GHG. The concept of CO_2-equivalency (CO_2e) is used to account for the different GWP potentials of GHGs to absorb infrared radiation.

Climate change is a global problem because GHGs are global pollutants, unlike criteria air pollutants and toxic air contaminants (TACs), which are pollutants of regional and local concern (see Section 3.9 *Air Quality* for more information on criteria air pollutants and TACs). Whereas pollutants with localized air quality effects have relatively short atmospheric lifetimes (approximately one day), GHGs have long atmospheric lifetimes

[140] The wavelength at which a body emits radiation is proportional to the temperature of the body.

(one year to several thousand years). GHGs persist in the atmosphere for enough time to be dispersed around the globe. The quantity of CO_2e that will ultimately result in measurable climate change is enormous; no single project could measurably contribute to a noticeable incremental change in the global average temperature, or to global, local, or micro-climate change.

Greenhouse Gas Emission and Inventory

As the second largest emitter of GHGs in the United States, and 20th largest in the world, California contributes a significant quantity of GHGs to the atmosphere (CARB 2017a). Emissions of CO_2, CH_4, and N_2O are byproducts of fossil-fuel combustion, and are attributed in large part to human activities associated with transportation, industry/manufacturing, electricity generation and natural gas consumption, and agriculture (CARB 2017a). In California, the transportation sector is the largest emitter of GHGs, followed by industrial activities (CARB 2015) (see Figure 3.10-2).

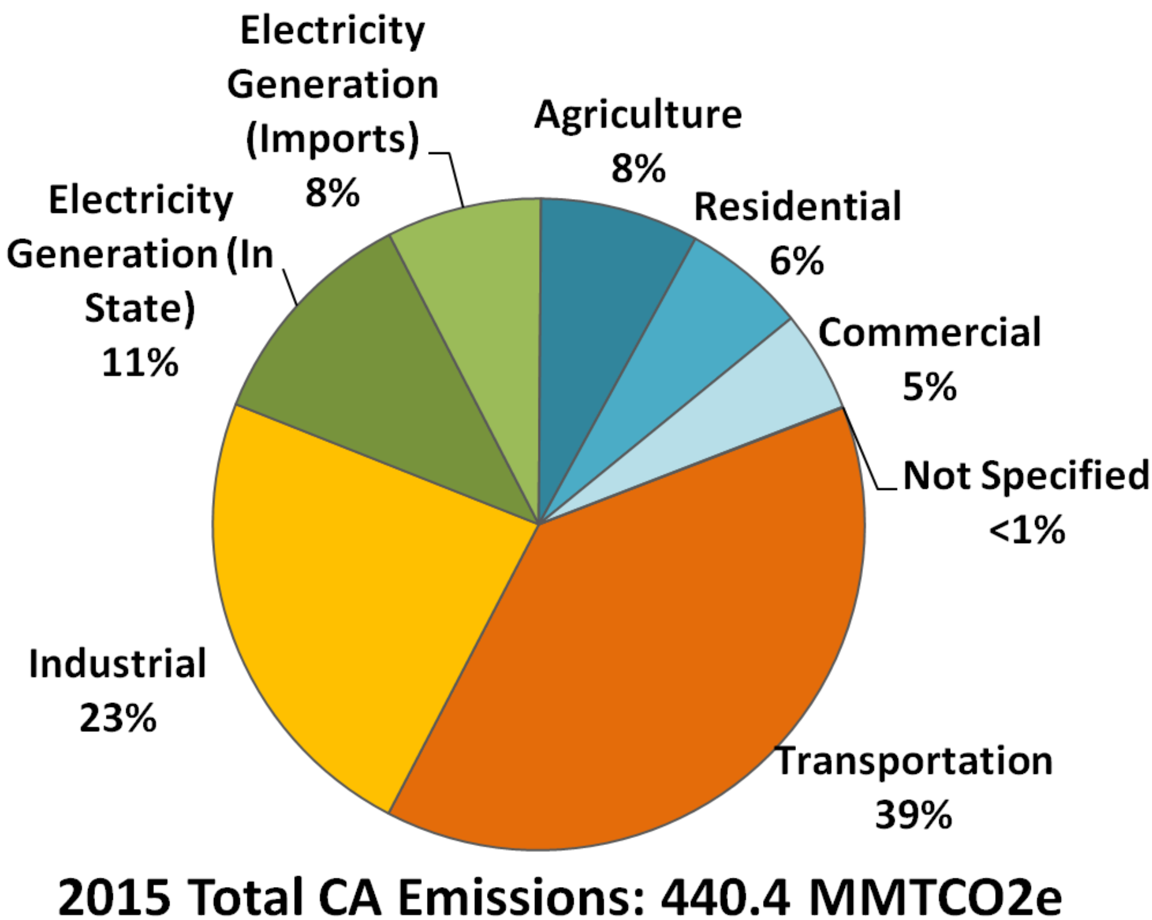

Figure 3.10-2. California GHC Emission Sources, in Million Metric Tons of CO_2e (as of 2015). Source: CARB 2015.

Statewide Effects of Climate Change

Climate change is anticipated to affect environmental conditions in California through a variety of mechanisms. One effect of climate change is sea-level rise. Sea levels along the California coast rose approximately 7 inches during the last century (CEC 2006a), and are predicted to rise an additional 7 to 22 inches by year 2100, depending on the future levels of GHG emissions (Stocker 2014). However, the Governor-appointed Delta Vision Blue Ribbon Task Force has recommended that California plan for a scenario of 16 inches of sea-level rise by year 2050, and 55 inches by year 2100 (CNRA 2008). Effects of sea-level rise could include increased coastal flooding, saltwater intrusion in the low-lying areas, and disruption of wetlands (CEC 2006a).

As the California climate changes over time, the range of various plant and wildlife species could shift or be reduced, depending on the favored temperature and moisture regimes of each species. In the worst cases, some species would become extinct if suitable conditions are no longer available. Additional concerns associated with climate change are a reduction in the snowpack, leading to less overall water storage in the mountains (the largest "reservoir" in the State), and increased risk of wildfire caused by changes in rainfall patterns and plant communities (CEC 2006a).

Regional Effects of Climate Change

Projected changes in climate conditions are expected to result in a wide variety of effects in the Pacific Northwest[141] and the Klamath Basin. The most relevant consequences related to the Area of Analysis for GHGs include changes to stream flow, temperature, precipitation, groundwater, and vegetation changes. In general, climate model projections include:

- Increased average ambient air and water temperature
- Increased number of extreme heat days
- Changes to annual and seasonal precipitation, including increased frequency and length of drought, less winter snow and more winter rain, and changes in water quality
- Increased heavy precipitation
- Reduced snow pack and snow melt, resulting in less runoff during the late spring through early autumn
- Vegetation changes
- Groundwater hydrology changes
- Changes to annual stream flow

Lower Klamath Project Facility Influence on GHG Emissions

The hydroelectric power that is generated by the Lower Klamath Project dam complexes is considered a renewable source of energy that produces significantly reduced GHG emissions relative to other non-renewable energy sources in the region that burn fossil fuels. GHG emissions generated by hydroelectric facilities are primarily from power plant operations and maintenance. In addition, there is also the potential for plant matter to decay in the reservoirs which can cause the buildup and release of methane. As discussed in Appendix N, the Karuk Tribe (2006) estimated the total amount of methane released from Keno, J.C. Boyle, Copco, and Iron Gate reservoirs in its comments on the

[141] The Pacific Northwest is defined by the U.S. Global Change Research Program (USGCRP) as Washington, Oregon, Idaho, and western Montana. Although the USGCRP "Pacific Northwest" region does not include California, it has the climate most representative of the Klamath Basin. The USGCRP region that contains California is the "Southwest" climate region, which includes California, Nevada, Arizona, Utah, and parts of New Mexico, Colorado, and Texas. The Southwest data represent primarily desert climates, which are less similar to the Klamath Basin.

Draft Environmental Impact Statement for relicensing and/or decommissioning of the Klamath Hydroelectric Project. The emissions estimation method presented by the Karuk Tribe was adapted for the analysis in Appendix N to estimate emissions from the water impounded in the reservoirs associated with the Lower Klamath Project dam complexes. According to Table O-2 in Appendix N, it is estimated that the methane produced by the Lower Klamath Project dam complexes ranges from 4,000 to 14,000 metric tons of CO2e annually.

As Section 3.2 *Water Quality* and Section 3.4 *Phytoplankton and Periphyton* describe in detail, the Klamath River produces significant concentrations of algae, particularly in the Copco No. 1 and Iron Gate reservoirs. The primary types of algae found in these reservoirs have been diatoms (prevalent throughout the Klamath River system) and two types of cyanobacteria: *Aphanizomenon flos-aquae* and *Microcystis aeruginosa*. As with other forms of biomass, algae sequester GHGs during photosynthesis that would otherwise be in the atmosphere.

Algal production in the Lower Klamath Project reservoirs can result in temporary sequestration of CO_2 as carbon present in algal cells. When algae die at the end of their life and sink to the bottom of the Lower Klamath Project reservoirs, the temporarily sequestered carbon can be released back to the atmosphere during microbial decomposition. However, in the anoxic (lacking oxygen) environment of the Lower Klamath Project reservoir sediments, algal biomass can resist decomposition and continue to sequester carbon until disturbed and exposed to an oxygenated environment. For example, when sediments comprised of dead algae are released to downstream reaches of the Klamath River, they are subjected to oxygenated conditions and aerobic bacterial decomposition of the sediments would release sequestered carbon.

3.10.2.2 Energy

The Lower Klamath Project includes four hydroelectric developments along the mainstem of the Klamath River between river mile (RM) 193.1 and 229.8. As shown in Table 3.10-1, the installed generating capacity of the existing Lower Klamath Project is approximately 163 megawatts (MW) and, on average, the Lower Klamath Project generates 686,000 megawatt-hours (MWh) of electricity annually (PacifiCorp 2016).

Table 3.10-1. Lower Klamath Project Dam Complexes.

Dam Complex Name	Generating Facility	Total Authorized Generating Capacity (MW)	Average Annual Generation (MWh)	Location	River Mile
Copco No. 1 Dam and Reservoir	Copco No. 1 Powerhouse	20.0	106,000	California	201.8 to 208.3
Copco No. 2 Dam and Reservoir	Copco No. 2 Powerhouse	27.0	135,000	California	201.5 (Dam) and 200 (Powerhouse)
Iron Gate Dam and Reservoir	Iron Gate Powerhouse	18.0	116,000	California	193.1 to 200.0
J.C. Boyle Dam and Reservoir	J.C. Boyle Powerhouse	97.98	329,000	Oregon	229.8 (Dam) and 225.2 (Powerhouse)
Total	**--**	**162.98**	**686,000**	**--**	**--**

Source: FERC 2007, river miles updated based on Appendix B: *Definite Plan*.

The Lower Klamath Project in California includes Copco No. 1, Copco No. 2, and Iron Gate facilities. As shown in Table 3.10-1, these developments have a generation capacity of approximately 65 MW of electricity and produce an average of 357,000 MWh of electricity annually. This accounts for approximately 52 percent of the Lower Klamath Project total generation.

Although the J.C. Boyle dam complex is located in Oregon, it is being considered in this section since removal of this dam is related to the Proposed Project and the emissions of greenhouse gases are inherently a cumulative impact.

3.10.3 Significance Criteria

Criteria for determining significant impacts of GHGs and energy are based upon Appendices F and G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and best professional judgment. Effects of GHGs and changes in energy production are considered significant if the Proposed Project would result in one or more of the following conditions or situations:

1. Generation of GHG emissions, either directly or indirectly, that would exceed 10,000 MT CO_2e.
2. Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases.

Significance Thresholds

The nature of the GHG emissions from the Proposed Project differs from most projects considered highest priority for curbing emissions either on a statewide or regional basis. Typical emission sources considered for quantitative thresholds of significance involve construction and ongoing operational emissions from stationary industrial projects with high rates of combustion emissions (e.g., refineries, power plants, other processing that uses industrial boilers) or the construction and increased power and transportation needs from newly constructed residential or commercial projects.

The Siskiyou County Air Pollution Control District (SCAPCD) has not adopted quantitative thresholds for determining the significance of greenhouse gas emissions. In the absence of quantitative significance thresholds for GHG emissions in the SCAPCD, the calculated GHG emissions from the Proposed Project are compared to quantitative thresholds of significance adopted by other air districts in California. The South Coast Air Quality Management District (SCAQMD) and the Bay Area Air Quality Management District have adopted numerical CEQA thresholds of significance for GHG emissions from the operation of industrial projects. Both districts use a threshold of 10,000 metric tons (MT) CO_2e per year for industrial projects that would capture 90 percent of all operational GHG emissions from stationary sources in each air basin (BAAQMD 2017, SCAQMD 2008).

Since the project proposes construction activity related to the decommissioning of the Lower Klamath Project dam complexes that would be completed at the end of 2021, it does not include long-term operational emissions. Unlike operational emissions, construction emissions do not occur continuously over the lifetime of a project. Rather, construction emissions are temporary emissions that are spread out over the construction period. Therefore, the application of the 10,000 $MTCO_2$e operational GHG emissions significance threshold for construction emissions from the Proposed Project is conservative because these emissions are limited in duration. As such, a GHG impact would be significant if the construction emissions from the Proposed Project exceed the 10,000 $MTCO_2$e threshold.

A GHG impact would be significant if GHG emissions from the Proposed Project would substantially obstruct compliance with the GHG emission reduction goals in Assembly Bill (AB 32), Senate Bill 32 (SB 32), and Executive Order S-3-05 (EO S-3-05). In addition, an impact would be significant if the removal of the Lower Klamath Project hydroelectric facilities would conflict with the California Renewable Portfolio Standard (RPS) (S-14-08, SB X1-2, and SB 350). AB 32 established the goal for the reduction of California's GHG emissions to 1990 levels by 2020. SB 32 established the goal of reducing emissions 40 percent under 1990 levels by 2030. Executive Order S-3-05 established the goal of reducing emissions 80 percent under 1990 levels by 2050. The California RPS established the goals of requiring retail sellers of electricity to provide a power mix that includes 33 percent renewable sources by 2020 and 50 percent renewable sources by 2030.

Following the passage of AB 32, some of the regional air districts in the state, such as the SCAQMD and BAAQMD, based their planning and regulations on the requirements of AB 32. These air districts set forth GHG significance thresholds specifically to meet AB 32 requirements, and so plans and projects that meet those thresholds can be assumed to meet the requirements of AB 32 (BAAQMD 2017). This includes the 10,000 $MTCO_2$e threshold for industrial projects that is compared to the construction emissions from the Proposed Project. If the Proposed Project will generate construction emissions that are less than this threshold, then it would not conflict with the AB 32 goal of reducing GHG emissions to 1990 levels by 2020.

Prior to the adoption of AB 32, EO S-3-05 established the goal of reducing California's emissions 80 percent under 1990 levels by 2050. In 2016, SB 32 was signed into law, establishing the state's mid-term target for 2030 emissions to be 40 percent below the 1990 emissions. The plan outlined in Senate Bill 32, involves increasing renewable energy use, putting more electric cars on the road, improving energy efficiency, and curbing emissions from key industries. Adopted regulations that correspond to elements of the Scoping Plan include the Renewable Portfolio Standard, the Cap-and-Trade Program, and the Low Carbon Fuel Standard (CARB 2017b). Since the Proposed Project involves construction activity related to the decommissioning of the Lower Klamath Project dam complexes that will be completed at the end of 2021, and the Proposed Project will not have long-term operational emissions, the potential for the project to conflict with the goals in EO S-3-05 and SB 32 is limited. Despite this, a discussion of the Proposed Project's compliance with existing regulatory requirements (e.g., low carbon fuel standards) and the California RPS is included under Potential Impact 3.10-2 to assess whether the Proposed Project will conflict with the GHG reduction goals in EO S-3-05 and SB 32.

In 2002, California established an RPS that requires a retail seller of electricity to include in its resource portfolio a certain amount of electricity from renewable energy sources, such as wind, geothermal, and solar energy. The retailer can satisfy this obligation by using renewable energy from its own facilities, purchasing renewable energy from another supplier's facilities, using Renewable Energy Credits (RECs) that certify renewable energy has been created, or a combination of all of these. California's RPS requirements have been accelerated and expanded a number of times since its inception. Most recently, Governor Jerry Brown signed into law Senate Bill (SB) 350 in October 2015, which requires utilities to procure 50 percent of their electricity from renewables by 2030. SB 350 also requires California utilities to develop integrated resource plans that incorporate a greenhouse gas emission reduction planning component. Compliance with the California RPS requires PacifiCorp to develop and implement an integrated resource plan that demonstrates they are on schedule to comply with the goals of providing 33 percent renewable sources by 2020 and 50 percent renewable sources by 2050.

3.10.4 Impact Analysis Approach

The quantification of direct GHG emissions was performed similarly to that of the Lower Klamath Project air quality analysis (Section 3.9 *Air Quality*) with a few exceptions (see discussion below). Project-related construction emissions were compared to applicable thresholds of significance to evaluate environmental impacts from GHGs. Direct short-term GHG emissions include those associated with on- and off-site construction equipment, construction worker commuting, and haul truck emissions. For this analysis, direct GHG emissions associated with the reduced operation of Iron Gate Fish Hatchery combined with the re-instated operation of Fall Creek Hatchery were set at the same as existing operation conditions at Iron Gate Hatchery for eight years following dam removal. This is due to the fact that the existing functions at the Iron Gate Hatchery that will be eliminated as part of dam removal activities, will be replaced by the reopening and operation of the Fall Creek Hatchery and by making improvements to the Iron Gate Hatchery (Section 2.7.6 *Hatchery Operations*).

Indirect GHG emissions were qualitatively analyzed, which includes potential GHG emissions associated with non-renewable power sources that could potentially be used to replace the hydropower associated with the Lower Klamath Project dam complexes on an interim basis.

The construction GHG emissions estimates used for this Lower Klamath Project EIR (Appendices N and O) were developed in 2011 as part of 2012 EIS/EIR analysis.

Although there have since been modifications to the Proposed Project schedule (Table 2.7-1), the 2011 GHG emissions modeling is still relevant as the construction-related activities and their associated emissions for the Proposed Project are materially similar to those modeled in 2011. Minor changes in proposed construction activities between the 2012 EIS/EIR analysis and the Proposed Project are primarily due to the timing associated with removing Iron Gate Dam, Copco No. 1 Dam, and Copco No. 2 Dam. The Proposed Project and the data modeled as part of the 2012 EIS/EIR are compared to the thresholds noted in Section 3.10.3 *Significance Criteria* and analyzed in Section 3.10.5 *[Greenhouse Gas Emissions] Potential Impacts and Mitigation*.

Greenhouse Gas Emissions Quantification

The Lower Klamath Project GHG analysis evaluated the following three pollutants: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Emissions of CO_2, CH_4, and N_2O were estimated for on- and off-site combustion sources, including mobile and stationary sources. The other two pollutants commonly evaluated in various mandatory and voluntary reporting protocols, hydrofluorocarbons and perfluorocarbons, are not expected to be emitted in large quantities and are not discussed further in this section. It is likely that sulfur hexafluoride (SF_6) would be released during deconstruction because the circuit breakers from the power facilities would be emptied. Although SF_6 has a relatively high GWP, sufficient data was not available at the time of this writing to quantify emissions.

Each GHG contributes to climate change differently, as expressed by its GWP. GHG emissions are discussed in terms of carbon dioxide equivalent (CO_2e) emissions, which express, for a given mixture of GHG, the amount of CO_2 that would have the same GWP over a specific timescale. CO_2e is determined by multiplying the mass of each GHG by its GWP[142]. This analysis uses the GWP from the Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report (IPCC 1996) for a 100-year period to estimate CO_2e. Although subsequent assessment reports have been published by the IPCC, the international standard, as reflected in various federal, state, and voluntary reporting programs, is to use GWPs from the Second Assessment Report.

Direct GHG emissions were calculated for construction activities related to dam demolition including heavy equipment use, hauling of demolition debris to landfills, and worker transportation. Detailed calculations for the Proposed Project are provided in Appendices N (Air Quality Supplemental Methodology Information and Detailed Impact Analyses) and O (Greenhouse Gas Emissions Impacts).

If a United States Environmental Protection Agency (USEPA)-approved emissions factor model (e.g., EMFAC2007, MOBILE6.2, OFFROAD, or NONROAD) does not estimate emissions of a particular pollutant, then emission factors were obtained, if possible, from the Federal Mandatory Reporting of Greenhouse Gases Rule (40 CFR Part 98).

A combination of techniques was used to estimate emissions from reservoir restoration activities. Emissions from landing and takeoff operations associated with aerial seed application were estimated using the Federal Aviation Administration's Emissions and

[142] As an example, CH_4 has a GWP of 21, as specified in the Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report (1996). One metric ton of CH_4 is equal to 21 metric tons of CO_2e (1 metric ton x 21).

Dispersion Modeling System. Emissions from hydroseeding barges were estimated using the following sources listed below.

- Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (USEPA 2000)
- AP-42, Chapter 3.3: Gasoline and Diesel Industrial Emissions (USEPA 1995)
- Title 17 California Code of Regulations, Section 93115.7: Air Toxic Control Measure for Stationary Compression Ignition Engines – Stationary Prime Diesel-Fueled Compression Ignition Engine (>50 bhp) Emission Standards
- Title 13 California Code of Regulations, Section 2423: Exhaust Emission Standards and Test Procedures—Off-Road Compression-Ignition Engine

Emissions from ground support equipment were estimated using the emission factors for off-road engines identified above and EMFAC for on-road motor vehicle emissions.

The California Emissions Estimator Model, Version 2011.1.1, was used to estimate exhaust emissions that would occur from grading activities associated with restoring parking lots associated with recreational facilities proposed for removal and restoration. The California Emissions Estimator Model makes general assumptions about the quantity and types of construction equipment needed to grade a site based on its size (acreage).

The Sacramento Metropolitan Air Quality Management District's Road Construction Emissions Model, Version 6.3.2 (2009), was used to estimate exhaust emission factors associated with relocation of the Yreka water supply pipeline. The Siskiyou County Air Pollution Control District does not have a comparable model to estimate emissions from linear projects like the proposed pipeline relocation action.

Energy Conservation

Appendix F of the *State CEQA Guidelines* requires that an EIR shall include a "discussion of the potential energy impacts of proposed projects, with particular emphasis on avoiding or reducing inefficient, wasteful, and unnecessary consumption of energy."

There are no unusual project characteristics that would necessitate the use of construction equipment or practices that would be less energy efficient than at comparable construction sites in the region or State. Therefore, it is expected that construction energy consumption associated with the Proposed Project would not be any more inefficient, wasteful, or unnecessary than other similar construction projects of this nature. Therefore, this issue is not further addressed in this section.

This project proposes the removal of the Lower Klamath Project dam complexes and would not result in long-term energy use. For this analysis, energy use associated with the reduced operation of Iron Gate Fish Hatchery combined with the re-instated operation of Fall Creek Hatchery was set to be the same as existing conditions operations at Iron Gate Hatchery for the eight years following dam removal. This is due to the fact that the existing functions at the Iron Gate Hatchery that will be eliminated as part of dam removal activities, will be replaced by the reopening and operation of the Fall Creek Hatchery and by making improvements to the Iron Gate Hatchery (Section 2.7.6 *Hatchery Operations*). As such, the issue of energy conservation during long-term operation is not further addressed in this section.

CEQA Guidelines Appendix F indicates that "increasing reliance on renewable energy sources" is one of the means of achieving the goal of energy conservation (see Appendix F [I][3] and [II][D][4]). The Proposed Project will result in the decommissioning of the Lower Klamath Project hydroelectric facilities in California, which have a generation capacity of approximately 65 MW of electricity and produce an average of 357,000 MWh of electricity annually. As described in the PacifiCorp Integrated Resource Plan (IRP), PacifiCorp plans to transition to additional renewable energy sources, or purchase RECs, to provide a power mix that complies with the California Renewable Portfolio Standard (RPS). Although, the Proposed Project would result in the loss of a renewable energy source, overall PacifiCorp will be increasing the percentage of renewable energy sources in its power mix to comply with the California RPS.

3.10.5 Potential Impacts and Mitigation

Potential Impact 3.10-1 Generation of greenhouse gas emissions, either directly or indirectly, that would exceed 10,000 MT CO_2e.

The nature of the GHG emissions from the Proposed Project differs from most projects considered highest priority for curbing emissions either on a statewide or regional basis. Typical emission sources considered for quantitative thresholds of significance involve construction and ongoing operational emissions from stationary industrial projects with high rates of combustion emissions (e.g., refineries, power plants, other processing that uses industrial boilers) or the construction and increased power and transportation needs from newly constructed residential or commercial projects. In these cases ongoing emissions from combustion and transportation are likely to be cumulatively considerable.

For the Proposed Project, there are few direct operational GHG emissions. As noted above, direct GHG emissions associated with operation of the Iron Gate Hatchery and Fall Creek Hatchery are assumed to be the same as existing baseline GHG emissions associated with current hatchery operations. Appreciable direct GHG emissions would occur only for a limited time as a result of construction related to dam deconstruction, restoration, relocation and demolition of recreational facilities, and Yreka supply pipeline relocation.

However, the Proposed Project has the potential to indirectly produce GHG emissions through conversion from the hydroelectric energy produced by the Lower Klamath Project to regional power from a mixture of sources likely including GHG-emitting fossil fuels.

Summary

Table 3.10-2 summarizes the total uncontrolled emissions associated with the Proposed Project activities including dam and powerhouse deconstruction, restoration activities, relocation and demolition of recreational facilities, and the Yreka supply pipeline relocation. The GHG emissions estimates in Table 3.10-2 include construction activity related to the removal of J.C. Boyle Dam in Oregon. Due to the cumulative nature of GHG emissions, the emissions from construction activity in Oregon are conservatively added to the emissions from construction activity in California and compared to the SCAQMD's 10,000 $MTCO_2$e significance threshold.

Table 3.10-2. Uncontrolled Direct GHG Emissions Inventories for the Proposed Project.

Project Activity	Emissions ($MTCO_2e$)
Dam and Powerhouse Deconstruction	8,558
Restoration Activities	704
Recreation Facilities	160
Yreka Supply Pipeline Relocation	33
Total Emissions	**9,455**

Source: Appendix N

As shown in Table 3.10-2, total GHG emissions from the Proposed Project are estimated to be approximately 9,455 $MTCO_2e$, which is below the SCAQMD's 10,000 $MTCO_2e$ significance threshold. As such, the construction GHG emissions from the Proposed Project would be less than significant. The discussion below provides more detailed information about the emissions from the various project activities.

Dam and Powerhouse Deconstruction

Vehicle and equipment exhaust from dam removal activities would produce GHG emissions during the dam deconstruction period. The emission sources would include off-road construction equipment, on-road trucks, and construction worker commuting vehicles (Section 2.7.1 *Dam and Powerhouse Deconstruction*). Table 3.10-3 summarizes uncontrolled emissions associated with dam and powerhouse deconstruction.

Table 3.10-3. Uncontrolled Direct GHG Emissions Inventories for Dam and Powerhouse Deconstruction.

Location	Project Emissions ($MTCO_2E$)			
	CO_2	CH_4	N_2O	Total
Iron Gate	4,106	4	0	4,110
Copco No. 1	1,459	1	0	1,461
Copco No. 2	970	1	0	971
J.C. Boyle	2,016	<1	0	2,016
Total Emissions	**8,551**	**6**	**0**	**8,558**
California Total	6,535	6	0	6,542
Oregon Total	2,016	n/a	0	2,016

Source: Appendix N

As Table 3.10-3 shows, deconstruction of the dams would contribute approximately 8,558 $MTCO_2e$ of GHG emissions during the deconstruction period. As indicated in Table 3.10-2, deconstruction of the dams would produce the majority of construction emissions that would occur from the Proposed Project.

Cofferdams would be constructed at the Lower Klamath Project during deconstruction activities from concrete rubble, rock, and earthen materials that would come from the dam removal activities, as possible. Construction of the cofferdams from materials salvaged from the dam demolition activities would reduce the need for importing new construction materials. As the cofferdams would be constructed from materials salvaged from the dam demolition activities, GHG emissions associated with cofferdam construction would already be included in the emissions inventory. Additional emissions could occur when the cofferdams are later demolished. Due to the limited size of these structures and the fact that much of the material used to construct the coffer dams would be disposed of in close proximity to the dam sites, it is not anticipated that the additional emissions from this activity would result in a change to the significance determination.

Restoration Activities

Restoration actions included in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) would produce GHG emissions from the use of helicopters, trucks, and barges. Following drawdown of the reservoirs, revegetation efforts would be initiated to support establishment of native wetland, riparian, and upland species on newly exposed sediment. Additional fall seeding may be necessary to supplement areas where spring hydroseeding was unsuccessful. Table 3.10-4 summarizes GHG emissions from restoration activities.

Table 3.10-4. Uncontrolled Direct GHG Emissions Inventories for Restoration (Seeding).

Location	Project Emissions ($MTCO_2E$)			
	Ground Equipment	Barges	Aerial	Total
Iron Gate	29	88	149	266
Copco No. 1 and Copco No. 2	32	88	298	419
J.C. Boyle	19	n/a	n/a	19
Total Emissions	**80**	**177**	**447**	**704**

Source: Appendix N

As shown in Table 3.10-4, total GHG emissions from restoration activities are estimated to be approximately 704 $MTCO_2e$. As indicated in Table 3.10-2, next to deconstruction of the dams, restoration activities would be the second largest contributor of the construction emissions that would occur from the Proposed Project.

Recreation Facilities

Relocation and demolition of various recreation facilities (Section 2.7.8.3 *Recreation Facilities Management*) would produce GHG emissions from vehicle exhaust. The demolition of the Lower Klamath Project recreation facilities would change recreation opportunities from reservoir-based recreation to river-based recreation. This change would require several recreation facilities to be relocated or demolished. On- and off-road construction equipment would be used to complete these activities. GHG emissions from recreation facilities removal and construction were estimated using the California Emissions Estimator Model (CalEEMod). Approximately 160 $MTCO_2e$ would be emitted during relocation and demolition of the recreation facilities (Appendix N).

City of Yreka Water Supply Pipeline Relocation

Construction of a new Yreka water supply pipeline (Section 2.7.7 *City of Yreka Water Supply Pipeline Relocation*) would produce GHG emissions from vehicle exhaust. On- and off-road construction equipment would be used to complete the relocation and construction of the water supply pipeline. Construction of the pipeline is to occur prior to initiating drawdown of the Iron Gate Reservoir. It is estimated the replacement of the water supply pipeline would last approximately one month. The Sacramento Metropolitan Air Quality Management District's Road Construction Emissions Model (2009) was used to estimate emissions associated with grubbing/land clearing, grading/excavation, and other phases of construction. The Road Construction Emissions Model estimated that approximately 33 $MTCO_2e$ would be emitted.

Replacement of Hydroelectric Energy

Removing a renewable source of energy by removing the dams has the potential to result in increased GHG emissions from possible non-renewable alternate sources of power. GHG emissions could occur in the event that the renewable source of power represented by the Lower Klamath Project was replaced by other regional power sources, which in part, could be generated from fossil fuels.

As described above, the average annual electricity generation from the Lower Klamath Project is 686,000 MWh (Table 3.10-1). This includes generation from the following developments: Copco No. 1 Dam, Copco No. 2 Dam, Iron Gate Dam, and J.C. Boyle Dam. The Lower Klamath Project dam complexes in California (Copco No. 1, Copco No. 2, and Iron Gate) have a generation capacity of approximately 65 MW of electricity and produce an average of 357,000 MWh of electricity annually. This accounts for approximately 52 percent of the Lower Klamath Project total electrical production.

The 2015 electricity generation resource mix for PacifiCorp's Power Control Area (PCA), which is a region of the power grid in which all power plants are centrally dispatched, is dominated by coal (62 percent), natural gas (15.4 percent), wind (7.1 percent), and hydroelectricity (5.2 percent) (PacifiCorp 2017a). Electricity produced from the Lower Klamath Project, if removed, would likely be replaced with another source within the PacifiCorp PCA because the amount of electricity provided by the Lower Klamath Project is only approximately two percent of PacifiCorp's total generation capacity (CEC 2006b).

In 2017, PacifiCorp issued an Integrated Resource Plan (IRP) identifying the preferred power generation portfolio over the next 20 years. The IRP indicates that PacifiCorp plans to meet new energy resource needs primarily through new renewable resources and demand management (e.g., energy efficiency measures) over the 20-year (2017–2036) planning horizon. The IRP includes the anticipated loss of Lower Klamath Project hydroelectric generation beginning in 2020. The preferred portfolio also identified a reduction in coal capacity of 3,650 MW through the end of 2036. PacifiCorp projects that between 2017 and 2036 its average annual CO_2 emissions would be reduced by 24.5 percent falling from 43.8 million tons in 2017 to 33.1 million tons in 2036 representing an annual average reduction in CO_2 emissions of 10.7 million tons (PacifiCorp 2017b).

Removal of the reservoirs associated with the Lower Klamath Project dam complexes would also result in a reduction in methane (CH_4) production. As previously described, CH_4 emissions from the reservoirs range from 4,000 to 14,000 $MTCO_2e$ per year. Under the Proposed Project, these CH_4 emissions would cease to be a factor and would further reduce GHG emissions beyond the projections in the PacifiCorp 2017 IRP.

Since it is planned in the 2017 IRP for PacifiCorp to add new sources of renewable power or purchase RECs to comply with the California RPS, and removal of the reservoirs would result in a reduction in methane production, it is not anticipated that the replacement of the hydroelectric energy from the Lower Klamath Project dam complexes would result in an increase in GHG emissions from non-renewable power sources. As such, GHG impacts from replacement of the hydroelectric energy from the Lower Klamath Project dam complexes is determined to be less than significant.

Significance
No significant impact

Potential Impact 3.10-2 Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing GHG emissions.
Climate change is a cumulative phenomenon, and it is not possible to link a single project to specific climatological changes. The Proposed Project would result in temporary direct GHG emissions from construction and restoration related activities, but would not include direct operational GHG emissions. However, the Proposed Project could result in additional indirect emissions from non-renewable replacement power that could potentially be provided until PacifiCorp adds new sources of renewable power that would replace the removed dams.

For the purposes of this analysis, the Proposed Project is analyzed for compliance with the following applicable plans, policies, and regulations:

- Assembly Bill 32 (AB 32)
- Executive Order S-3-05 (EO S-3-05) and Senate Bill 32 (SB 32)
- Renewable Portfolio Standard (RPS) (S-14-08, SB X1-2, and SB 350)

Assembly Bill 32 (AB 32)
The Global Warming Solutions Act of 2006 (AB 32) directed the CARB to develop the Climate Change Scoping Plan (Scoping Plan), which outlines a set of actions to achieve the AB 32 goal of reducing GHG emissions to 1990 levels by 2020 (CARB 2008). CARB approved the Scoping Plan in 2008 and updated it in May 2014 and November 2017.

As discussed under Potential Impact 3.10-1, the construction emissions from the Proposed Project would fall below the 10,000 $MTCO_2e$ significance threshold developed by the SCAQMD and BAAQMD to provide consistency with AB 32. Since the project's GHG emissions would be below a GHG threshold developed to provide consistency with AB 32, the Proposed Project would not conflict with AB 32.

In addition, It is noted that CARB announced in July 2018, that the State has already met the AB 32 goal of reducing emissions to 1990 levels by 2020 approximately four years early. As stated in the Executive Summary of the 2018 Edition of the California Greenhouse Gas Emissions Inventory: 2000–2016 (CARB 2018):

> "The inventory for 2016 shows that California's GHG emissions continue to decrease, a trend observed since 2007. In 2016, emissions from routine GHG

emitting activities statewide were 429 million metric tons of CO2 equivalent (MMTCO2e), 12 MMTCO2e lower than 2015 levels. This puts total emissions just below the 2020 target of 431 million metric tons. Emissions vary from year-to-year depending on the weather and other factors, but California will continue to implement its greenhouse gas reductions program to ensure the state remains on track to meet its climate targets in 2020 and beyond."

Executive Order S-3-05 (EO S-3-05) and Senate Bill 32 (SB 32)
Since the Proposed Project involves construction activity related to the decommissioning of the Lower Klamath Project dam complexes that would be completed at the end of 2021, and the Proposed Project would not have long-term operational emissions, the potential for the project to conflict with the goals in EO S-3-05 and SB 32 is limited. However, a discussion of the Proposed Project's compliance with existing regulatory requirements (e.g., low carbon fuel standards) and the California RPS is included below to assess whether the project would conflict with the GHG reduction goals in EO S-3-05 and SB 32.

In 2016, the CARB released the updated Mobile Source Strategy, which addresses the current and proposed programs for reducing mobile source emissions, including GHG emissions. The Mobile Source Strategy identifies programs that the state and federal government have or would adopt, which further the goals of the Scoping Plan. Some programs provide incentives to facilitate increased purchase of new, lower emission light-, medium-, and heavy- duty vehicles to aid the state in achieving emission reduction goals. Other programs require certain engine years to upgrade the engine to newer, cleaner engines by specific dates or strict performance standards for specific model years. These programs for more stringent emission are required by state and federal law and are monitored by CARB or USEPA (CARB 2016). As such, the vehicles used during construction of the Proposed Project are required to comply with the applicable GHG reduction programs. KRRC or the construction contractor are required to provide verification of compliance to CARB or USEPA under state and federal law.

As described below, PacifiCorp plans to add new sources of renewable power or purchase RECs to comply with the California RPS. As such, the power mix provided by PacifiCorp after removal of the Lower Klamath Project dam complexes would comply with regulations that support the goals identified in S-3-05 and SB 32.

Therefore, the Proposed Project and the power mix that would be provided by PacifiCorp after removal of the Lower Klamath Project dam complexes, would conform with relevant actions and programs detailed in the Scoping Plan and Mobile Source Strategy. As such, the Proposed Project would not conflict with EO S-3-05 and SB 32.

Renewable Portfolio Standard (RPS) (S-14-08, SB X1-2, and SB 350)
In 2017, PacifiCorp issued an Integrated Resource Plan (IRP) identifying the preferred power generation portfolio over the next 20 years that "reflects a cost-conscious transition to a cleaner energy future". The IRP indicates that PacifiCorp plans to meet new energy resource needs primarily through new renewable resources and demand management (e.g., energy efficiency measures) over the 20-year (2017–2036) planning horizon by adding approximately 4,000 MW of wind and solar resources and 2,100 MW through energy efficiency and load control. The IRP includes the anticipated loss of Lower Klamath Project hydroelectric generation beginning in 2020. The preferred portfolio also identified a reduction in coal capacity of 3,650 MW through the end of

2036. As it relates to compliance with the California RPS, the PacifiCorp IRP concludes that the California RPS compliance position is improved by the addition of repowered wind, new renewable resources and transmission in the 2017 IRP preferred portfolio and would require the purchase of under 150,000 RECs per year to achieve compliance through the planning horizon.

Although the Proposed Project would result in the loss of a renewable energy source, overall PacifiCorp would be increasing the percentage of renewable energy sources in its power mix to comply with the California RPS. Since it is planned in the 2017 IRP for PacifiCorp to add new sources of renewable power or purchase RECs to comply with the California RPS, the Proposed Project would not conflict with the State's RPS.

As such, the Proposed Project would not conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases.

Significance

No significant impact

3.10.6 References

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3.11 Geology, Soils, and Mineral Resources

3.11.1 Area of Analysis

This section analyzes potential impacts on geology, soils, and mineral resources related to implementation of the Proposed Project. The Area of Analysis for geology, soils, and mineral resources includes the riverbed and reservoir slopes at the sites of the Iron Gate, Copco No. 1, and Copco No. 2 dam complexes; as well as the Klamath River bed and banks from the California-Oregon state line to the Pacific Ocean, including the Klamath River Estuary. Areas of the Upper Klamath Basin in Oregon are discussed in this section only to the extent they pertain to potential impacts to geology, soils, and mineral resources in California.

The assessment of potential impacts to geology, soils, and mineral resources includes the following reaches of the Klamath River defined by changes in physiography, presence of the developments included in the Lower Klamath Project, and tidal influence (Figure 3.11-1):

1. Hydroelectric Reach (from the upstream extent of J.C. Boyle Reservoir to Iron Gate Dam), including the following:
   a. J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate reservoirs
   b. J.C. Boyle Bypass and Peaking reaches
   c. Copco No. 2 Bypass Channel;
2. Klamath River downstream of Iron Gate Dam to the Pacific Ocean;
3. Klamath River Estuary; and
4. Pacific Ocean nearshore environment.

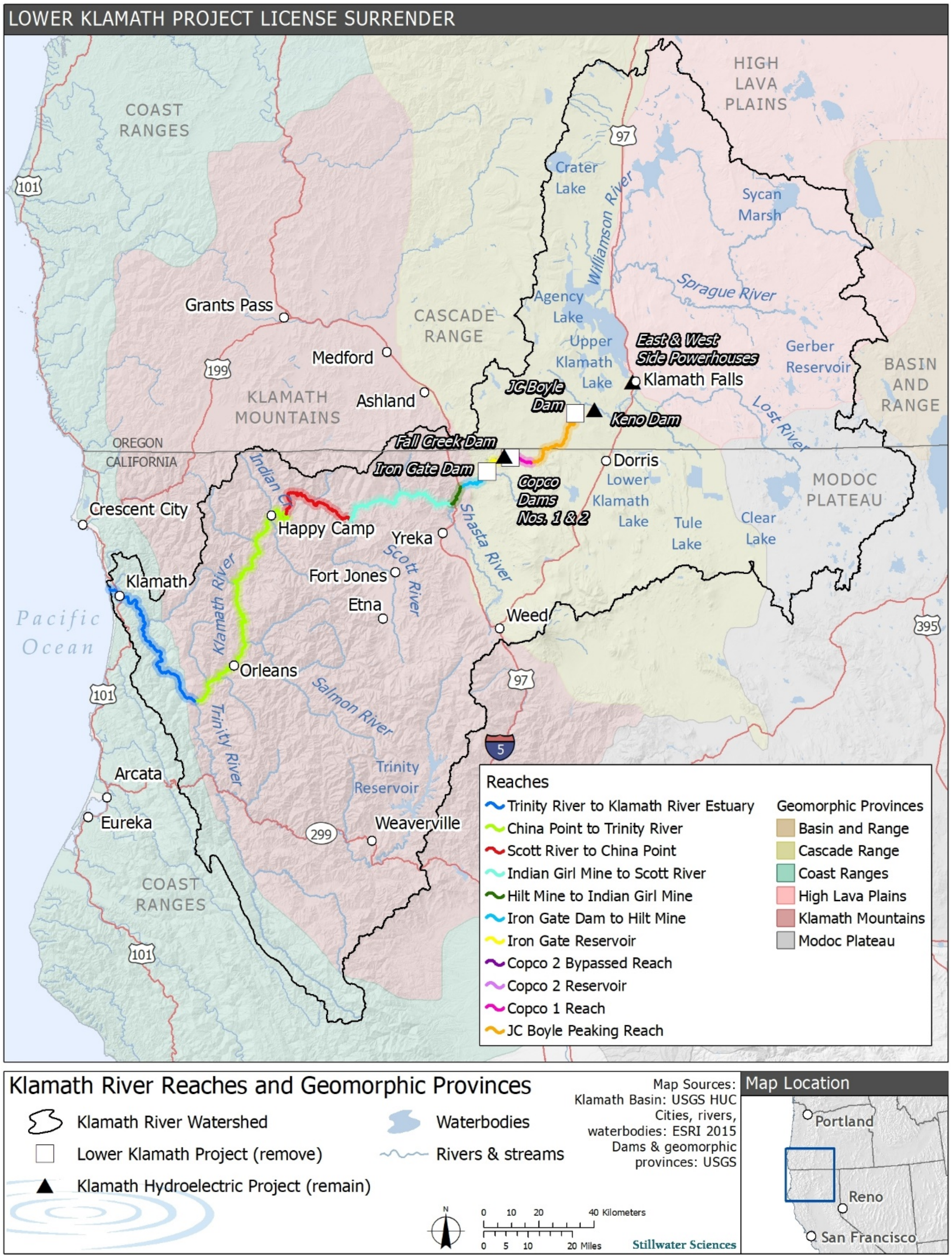

Figure 3.11-1. Geomorphic Provinces in the Klamath Basin and Geomorphic Reaches within the Area of Analysis for Geology and Soils.

3.11.2 Environmental Setting

The Proposed Project would erode sediment from reservoir deposits and transport this sediment to downstream reaches of the Klamath River. The following description of the geology and soils environmental setting therefore focuses primarily on the geology and geomorphology of the reservoir, channel, and floodplain environments directly and indirectly affected by dam removal and the associated release of stored sediment to downstream reaches of the Klamath River.

The Klamath River traverses approximately 260 river miles (approximately 214 river miles in California and 46 river miles in Oregon), originating in Upper Klamath Lake in southern Oregon and cutting southwest through the Klamath Mountains and northern California Coast Range to the Pacific Ocean near Requa. With a watershed area of approximately 15,722 mi^2, the Klamath River produces the second largest average annual runoff (Kruse and Scholz 2006) and sediment flux (Willis and Griggs 2003) of California's rivers.

The USBR refers to areas upstream of Iron Gate Dam as the Upper Klamath Basin and areas downstream of Iron Gate Dam as the Lower Klamath Basin (USBR 2012). These generalized basin areas are further subdivided based on geomorphic terrains with distinctly different geologic, geomorphic, hydrologic, climatic, vegetative, and resulting land use characteristics.

3.11.2.1 Regional Geology

Bedrock Geology

The geologic history of the Klamath River basin follows the interaction of three tectonic plates: the Pacific, the North American, and the Juan de Fuca. As a result, the Klamath River downstream of J.C Boyle Dam flows through three distinct geomorphic provinces: the Cascade Range Province, the Klamath Mountains Province, and the Coast Range Province (Figure 3.11-1) (CGS 2002). Each geomorphic province uniquely influences hydrology; channel morphology; and the supply of water, sediment, nutrients, and wood originating from tributary rivers and streams.

The portion of the Upper Klamath Basin located upstream of Upper Klamath Lake drains two geomorphic provinces: High Lava Plains and Modoc Plateau, composed predominantly of Miocene age basalts. The permeable volcanic rocks and subdued relief in these geomorphic provinces result in low drainage density, low stream gradients, and large internally drained areas that are typically filled with volcaniclastic sediment, alluvial fan deposits, and lake sediment (e.g., Upper Klamath, Lower Klamath, and Tule lakes). The Upper Klamath Basin also lies in the rain shadow of the Klamath and Cascade mountain ranges, and streamflow is largely from relatively steady groundwater flow. Low channel gradients, limited surface runoff, and internal drainage contribute to a muted hydrologic response to storm events and low sediment yield to the Klamath River.

The Lower Klamath Project is located in the Cascade Range Province, comprised predominantly of andesitic volcanic rocks of Cenozoic age. The Cascade Range Province is divided into the Western Cascade Sub-Province and the High Cascades Sub-Province based on the age and style of volcanism (Mertzman and Hazlett 1997, Taylor 1990). The Western Cascade Sub-Province is dominated by calc-alkaline continental margin andesites extruded about 40 million years ago (Mertzman and Hazlett

1997). The High Cascades Sub-Province is younger (Quaternary age) and is distinguished by lava flows, lava shields, pyroclastic flows, tuffs, cinder cones, and classic cone shaped stratovolcanoes.

The Mid-Klamath Basin is a subdivision of the basin located between approximately Iron Gate Dam the Trinity River confluence. The Mid-Klamath Basin occurs predominantly within the Klamath Mountains Province and is underlain by a series of geologic terranes comprised of accreted oceanic lithosphere, volcanic arcs, and mélange (Irwin 1994). The terranes were successively accreted to the convergent margin of western North America through a series of tectonic episodes. Each band of accreted material composing a terrane served as the backstop for the successive accretionary episode. Widespread metamorphism, folding, and faulting occurred in both the continental and accreted rocks during each episode. The complex geologic and geomorphic character of the Klamath Mountains reflects this tectonostratigraphic growth and subsequent plutonic intrusive, metamorphic, and volcanic activity that has occurred since the early Devonian geologic period (Irwin 1994). These rocks are more resistant to weathering and form high-relief terrain with prominent peaks and ridges.

The Lower Klamath Basin occurs farther west within the Coast Range Province and includes 40 miles of the Klamath River from approximately the Trinity River confluence to the Pacific Ocean. The Lower Klamath Basin is underlain mostly by the Eastern Belt of the Franciscan Complex and a narrow band of the Central Belt of the Franciscan Complex along the coast. The Eastern Belt is composed of schist and meta-sedimentary rocks (mostly metagraywacke) with minor amounts of shale, chert, and conglomerate. The Central Belt is principally an argillite-matrix mélange that contains kilometer-sized slabs of greenstone, serpentinite, graywacke, and abundant meter-size blocks of greenstone, graywacke, chert, higher-grade metamorphics, limestone, and lenses of serpentinite. The combination of tectonic deformation and shear, compositionally weak bedrock, and high precipitation rates in the Coast Ranges result in high erosion rates and sediment yields compared to other parts of the Klamath Basin (FERC 2007).

Faulting and Seismicity

The California Geological Survey (CGS) identifies seismic hazard zones according to the Alquist–Priolo Special Studies Zone Act of 1972 (Alquist-Priolo Act). Zone 4 is the highest rating requiring, compliance with the strictest building standards, while Zone 1 represents areas with the lowest probability of a seismic event. CGS has placed Siskiyou County in Seismic Zone 3 due to the presence of nearby active faults capable of surface rupture (CGS 2007).

Review of available fault and earthquake epicenter maps for northern California and southern Oregon show no fault lines or earthquake epicenters beneath Iron Gate Dam, Copco No. 1 Dam, Copco No. 2 Dam, or the Lower Klamath Project reservoirs. The Cedar Mountain fault is located approximately five miles east of the Klamath River in Siskiyou County (Table 3.11-1). The Hat Creek–McAuthur fault zone is located approximately 50 miles southeast of Copco No. 1 Dam. Other faults mapped by USGS, but not zoned under the Alquist–Priolo Act, include the Gillem–Big Crack fault, Pittville fault, Mayfield fault, and Rocky Ledge fault. Faults exist beneath the J.C. Boyle Dam and Reservoir; however, these faults have not moved within the past 1.5 million years and are considered inactive (Personius et al. 2003). No earthquake epicenters are mapped beneath the J.C. Boyle Reservoir, but one of the largest earthquakes recorded in Oregon occurred in 1993, with a magnitude of 6.0, in and around the Klamath Falls area approximately 15 miles north of the J.C. Boyle Reservoir. In California, the nearest active fault to the Lower Klamath Project is the Meiss Lake fault, approximately five miles east of the Klamath River near the California-Oregon State line in Siskiyou County. The next nearest California-zoned active fault in relation to the Lower Klamath Project is the Mahogany Mountain fault zone, approximately six miles east (Jennings and Bryant 2010).

Table 3.11-1. Earthquake and Fault Information.

Fault	Zoned by State of California [a]	Magnitude of Maximum Credible Earthquake (moment magnitude) [b]	Approximate Slip Rate (inches/year)	Approximate Recurrence Interval (years)
Cedar Mountain fault	Yes	6.9	0.04 [c]	3,600[c]
Hat Creek–McArthur faults	Yes	7	0.06 [c]	Unknown, possibly 1,000 to 3,000 [c]
Gillem–Big Crack faults	No	6.6	0.04 [c]	Not available
Pittville fault	No	6.7	less than 0.03 [c]	Not available
Mayfield fault	No	6.5	0.03–0.19 [c]	A few thousand years [c]
Rocky Ledge fault	No	N/A	less than 0.03 [c]	Not available

Sources:
[a] Bryant and Hart 2007
[b] Mualchin 1996
[c] USGS 2006

Based on the USGS earthquake database, the three largest earthquakes that have occurred closest to Copco No. 1, Copco No. 2, and Iron Gate dams were as follows. The first was located approximately 10 miles east of Copco No. 1 Dam and occurred with a magnitude of 3.3 on November 11, 1997. The second was located approximately 20 miles east of Copco No. 1 Dam and occurred with a magnitude of 3.0 on July 17, 1999. The third was located approximately 25 miles south of Iron Gate Dam and occurred with a magnitude of 2.5 on February 21, 2014.

Ground shaking is ground movement caused by seismic activity. Unlike surface rupture, ground shaking propagates into surrounding areas during an earthquake rather than being confined to a fault trace. A review of the CGS database indicates that the largest earthquake nearest the Lower Klamath Project, with the potential to have resulted in ground shaking near the Lower Klamath Project, occurred west of Eureka, California on November 8, 1980 (magnitude 7.3). Numerous earthquakes greater than magnitude 4.0 have occurred offshore west of Eureka (CGS 2007). The potential therefore exists for the soils and geology Area of Analysis to be affected by seismic ground shaking in the future.

Volcanism

Volcanism started in the Lower Klamath Project area approximately 40 million years ago and continued until approximately 10 and 5 million years ago. Volcanic activity shifted eastward, narrowed, and diminished in intensity over time. Estimates of the thickness of the Western Cascades strata range from between 12,000 and 15,000 feet to greater than 20,000 feet (PanGeo 2008). In the vicinity of Copco No. 1 Reservoir, the Klamath River has incised up to half of the Western Cascade strata, exposing inter-bedded tuffs, ash, and lava flows dipping east at approximately 25 degrees. These east-dipping Western Cascades strata are overlain by nearly flat-lying High Cascades strata composed of younger Pliocene lava flows with a cumulative thickness of up to 500 feet. Zones of inter-bedded Western Cascade strata may serve as geothermal reservoirs when coupled with a heat source and sealed by overlying High Cascades lava flows (Hammond 1983).

Volcanism in the vicinity of the Lower Klamath Project includes stratovolcanoes, lava domes, and cinder cones. Quaternary volcanics, including two Pleistocene cinder cones and associated lava flows, occur in the region between the eastern edge of Iron Gate Reservoir and Copco No. 1 Dam (GEC 2006, Wagner and Saucedo 1987). Within the past 10,000 years, Mount Shasta eruptions have occurred on average every 800 years. Over the past 4,500 years, eruptions have occurred on average every 600 years. The last known eruption occurred approximately 200 years ago (Miller 1980).

There are also a series of basaltic volcanoes extending northward from California into Oregon towards Klamath Falls, which have been dissected by subsequent block faulting in the Basin and Range Province (PanGeo 2008). In addition to the large shield volcanoes with their multiple eruptive events, numerous smaller vents and volcanoes are present in the area. The majority of the volcanism in the Upper Klamath Basin consists of single events from a given vent and most of the smaller explosive cones are formed from the interaction of flow material intersecting ground water (hydrovolcanic events). Tephra hazards zones are found in association with vents that have erupted in the last 10,000 years and are thought to be likely sources for future explosive eruptions of fragmental material (Miller 1989). The closest source of potential tephra is Mount Shasta, located approximately 40 miles from Iron Gate Dam. The Klamath River, from the Oregon-California state line to approximately the confluence of Seiad Creek, is within the 85-kilometer radius of an area subject to at least two inches or more of compacted ash (Miller 1989).

Pyroclastic flows are a mixture of hot gas and rocks. During an eruption, pyroclastic flows could travel northwest from Mount Shasta toward the Klamath River (Miller 1989). The farthest potential extent of pyroclastic flows has been delineated to the bank of the Klamath River.

Rapid melting of snow and ice during a volcanic eruption can lead to local flooding. The high sediment concentrations in flood waters generated by volcanic eruptions can be more damaging than flooding from rainfall runoff. The USGS has delineated this hazard downstream of Iron Gate Reservoir (Miller 1989).

Soils

Soils within the Klamath Basin span multiple geologies, terrains, and climates. Soils in the vicinity of the Upper Klamath River surrounding J.C. Boyle Reservoir and along the river south to the Oregon-California state line generally consist of lacustrine and alluvial clay, silt, fine-grained sand, and peat (Priest et al 2008). The primary soil association along both sides of the river is Skookum-rock outcrop-Rubble land complex with 35 to 70 percent slopes. Soils along the Klamath River within the Hydroelectric Reach in

California are less homogenous. Soils along the Klamath River downstream of Iron Gate Dam are generally composed of associations consisting of gravelly clay loam and gravelly sandy loam (Holland-Clallam, Skalan, Weitchpec, and Lithic Mollic Dubakella associations).

Soil types in the Area of Analysis can be grouped generally into those on steeper slopes, floodplain or terrace surfaces, or directly along the Klamath River itself. Soils on steeper slopes are shallow to moderately deep (typically 17 to 40 inches) and comprise a 7- to 8-inch surface horizon of gravelly loam; an underlying horizon of gravelly, clayey loam; and locally a very gravelly clay (FERC 2007). Floodplain or terrace surface soils comprise a deep, well-drained combination of alluvium (and in some places colluvium). These soils, as found within the canyon of the J.C. Boyle Peaking Reach, can be divided typically into a 15-inch very gravelly loam upper horizon, a transitional 6-inch gravelly clay loam layer, and a 39-inch horizon of heavy clay loam underlain by weathered bedrock to 60 inches or more below the surface (FERC 2007). The third soil type, located directly along the river, comprises unconsolidated alluvium, colluvium, and fluvial deposits. These geologically recent alluvial, low terrace, and landslide deposits consist of unconsolidated sand, silt, and gravels.

Mineral Resources

The CGS and the California Department of Conservation State Mining and Geology Board have classified Mineral Resource Zones (MRZs) in accordance with Sections 2761(a) and (b) and 2790 of the California Surface Mining and Reclamation Act of 1975 (SMARA). Lands categorized as MRZ-2 are underlain by "regionally significant" mineral resources that require that the CEQA lead agency's land use decisions be made in accordance with its mineral resource management policies, and that it consider the importance of the mineral resource to the region or the state as a whole. The primary source of information considered in this mineral resources analysis are the "mineral lands classification" maps published by the State pursuant to SMARA. Two comprehensive databases managed by the USGS (Minerals Availability System and Mineral Resource Data System) contain information regarding specific mineral locations.

Economically, the most important minerals that are extracted in the Area of Analysis for geology and soils are sand, gravel, and crushed rock (Figure 3.11-2, Table 3.11-2) (CGS/USGS 2004). Numerous small aggregate production areas are present. Other minerals that could be mined include asbestos, chromium, clay, copper, diatomite, gold, graphite, and mercury. The CGS has not prepared any reports that designate Mineral Resource Zones to be protected in Siskiyou County (Kohler 2002). The Siskiyou County General Plan does not contain a Mineral Resource Element and does not identify any specific areas of mineral resources within the county to be protected (Siskiyou County 1973).

Diatomite deposits surround much of the shoreline of Copco No. 1 Reservoir (PanGeo 2008). Diatomite is a chalk-like, very fine-grained sedimentary rock. It is used principally as a filter aid but has other commercial applications (USGS 2011). Near vertical bluffs have formed in the diatomaceous deposits as a result of undercutting due to wave erosion and failure of the weak material. Because of their location in the reservoir and existing erosion, diatomite resources are currently inaccessible for extraction purposes.

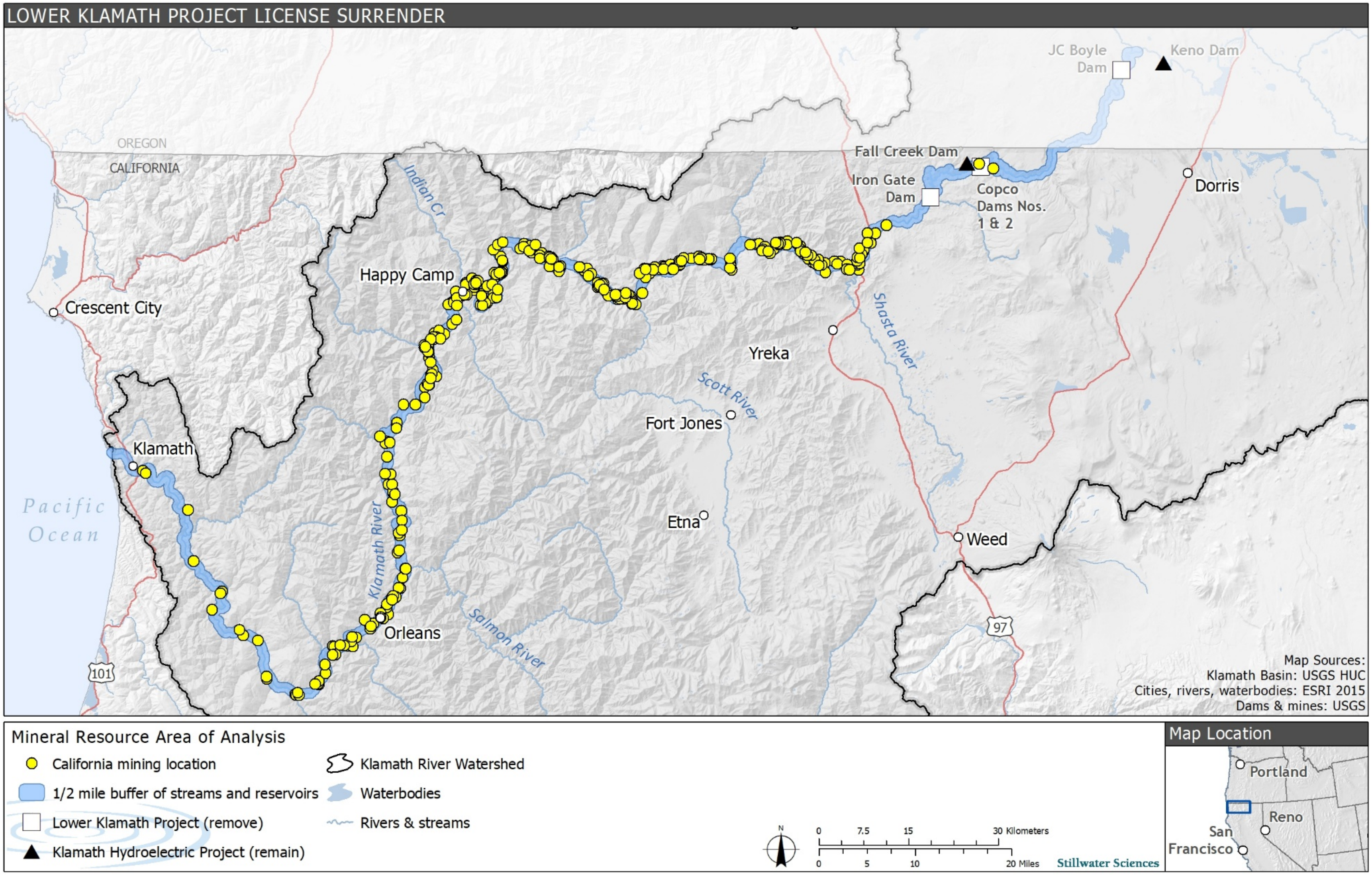

Figure 3.11-2. Mineral Resource Sites within the Area of Analysis for Geology and Soils.

Table 3.11-2. Mineral Resource Sites within the Area of Analysis for Geology and Soils.

Commodity	Occurrence	Past Producer	Producer	Prospect	Unknown	Total
Asbestos	1					1
Chromium	3			1	5	9
Clay	1					1
Copper	1	1			2	4
Diatomite	1					1
Gold	48	117	42	6	137	350
Graphite	2		1	1		4
Mercury	1				1	2
Sand and Gravel			3		1	4
Crushed Rock					1	1

3.11.2.2 Geomorphology

The geomorphology of the Klamath River in the Area of Analysis reflects the geology, hydrology, climate, and vegetation characteristic of the geomorphic provinces it flows through. The Klamath River within and downstream of the Hydroelectric Reach flows through steep, mountainous terrain and is generally a coarse-grained, bedrock-controlled channel with relatively short alluvial reaches and little floodplain development (Ayres Associates 1999). Channel morphology, degree of confinement, and bed surface grain size distribution are locally controlled by bedrock and by tributary flow and sediment inputs. The following sections provide a detailed description of the geology and geomorphology in channel reaches (Figure 3.11-1).

J.C. Boyle Reservoir

J.C. Boyle Reservoir (RM 229.8 to RM 233.3) transitions from a relatively wide and shallow upstream end, where the reservoir inundates a formerly low-gradient river valley, to a narrower and deeper downstream end, where the Klamath River incises into a bedrock canyon. The transition occurs at approximately RM 231. The bedrock surrounding and underlying J.C. Boyle Reservoir is principally inter-fingered volcanic deposits that are less than five million years old and are part of the High Cascade sub-province. Common lithologies include resistant basalt and basaltic andesite and less resistant volcaniclastic deposits. An outcrop of diatomite is present along the margin of the reservoir on the north side of the Klamath River by the prominent eastward bend (Appendix B: *Definite Plan*). The outcrop is at least 10 feet high and located at the foot of a rounded hill mapped as glacial material. The diatomite is underlain by black sand and is possibly interbedded with volcaniclastic material. The land surface surrounding the J.C. Boyle Reservoir is generally low gradient and underlain by competent materials. Spencer Creek enters the right bank at the upstream end of the reservoir.

J.C. Boyle Bypass and Peaking Reaches (RM 229.8 to 208.3)

The J.C. Boyle Bypass Reach begins in the Klamath Gorge downstream of J.C. Boyle Dam. Channel gradient in the bypass reach averages 1.4 to 2.3 percent. The channel through the upper portion of the bypass reach is typically composed of boulder and bedrock cascades with intermittent pools. The channel in the lower portion of the bypass reach is characterized by boulder to large cobble-bedded riffles, runs, and pools.

Rock fall from talus cones and block failures from cliff faces are the dominant sediment sources (FERC 2007).

The J.C. Boyle Peaking Reach begins as a wide, plane-bed channel just downstream of the powerhouse. The channel remains steep and boulder-dominated to the USGS gage (RM 224.4), downstream of which the steep (1.7 percent) channel is characterized by cobble-bedded riffles and runs with intermittent pools and gravel bars. Stepped terraces related to the thick lacustrine deposits occur from just downstream of J.C. Boyle Powerhouse to RM 219.1. The river is less steep (0.3 percent) in this segment, allowing for an increase in the size and frequency of finer sediment deposits (e.g., small cobble and gravel). At RM 219.1 the river becomes confined, channel gradient increases to 2 percent, and the channel bed and banks are composed of bedrock and boulders. Channel gradient decreases to approximately 0.8 percent and the river valley widens near the California state line (RM 213.8). Alternating riffles, runs, and pools characterize this section of the reach. A broad terrace within the peaking reach supports a riparian corridor, beyond which irrigated pastures occupy the floodplain. These channel conditions continue for the next five miles, where several side channels occur in conjunction with lateral bars and islands (FERC 2007). Shovel Creek, the largest tributary in this reach, enters the Klamath River from the left bank at RM 211.1.

Copco No. 1 Reservoir and Tributaries (RM 208.3 to 201.8)

Copco No. 1 Reservoir is located at a slope break in the Klamath River valley profile. The upper approximately 80 percent of the reservoir length inundates a low gradient reach of the river valley, while the lower 20 percent of the reservoir closest to the dam inundates a steeper reach. This slope break reflects base level control caused by emplacement of young volcanic deposits (e.g., Pleistocene cinder cones and associated lava flows, air fall tuff, and ash flows) that resulted in valley filling in the lower gradient upstream portion of the river valley. (FERC 2007, PanGeo 2008). Surficial deposits around Copco No.1 Reservoir include talus and rockfall debris, colluvium, alluvium and alluvial fans associated with tributary drainages, and older (likely Quaternary) fluvio-lacustrine terrace deposits (Appendix B: *Definite Plan*) (Figure 3.11-3). Fluvio-lacustrine terrace deposits surround much of the reservoir shoreline, extending to approximately 40 feet above the current reservoir level. These deposits consist of diatomite, fine-grained diatomaceous sediment and dense, coarse-grained alluvial deposits (Appendix B: *Definite Plan*). Lacustrine diatomite deposits also exist below the current range of reservoir levels, and appear as prominent benches in the bathymetry. Along the south shore, this bench is mostly continuous and ranges between 100 and 300 feet wide. Along the north shore, the bench is wider, with large peninsulas extending to the south with very steep to near vertical side slopes (Appendix B: *Definite Plan*). Multiple springs emerge from the hillside above the reservoir northeast of Copco Cove. Long Prairie Creek, Beaver Creek, Deer Creek, and Raymond Gulch drain to Copco No. 1 Reservoir.

Copco No. 2 Reservoir (RM 201.8 to 201.5)

Copco No. 2 Reservoir is a short impoundment (just over 0.25 mile) that lies immediately downstream of Copco No. 1 Dam. The narrow reservoir inundates a confined river valley deeply incised into the same young lava flows and associated volcanic rocks described above for the downstream portion of Copco No. 1 Reservoir.

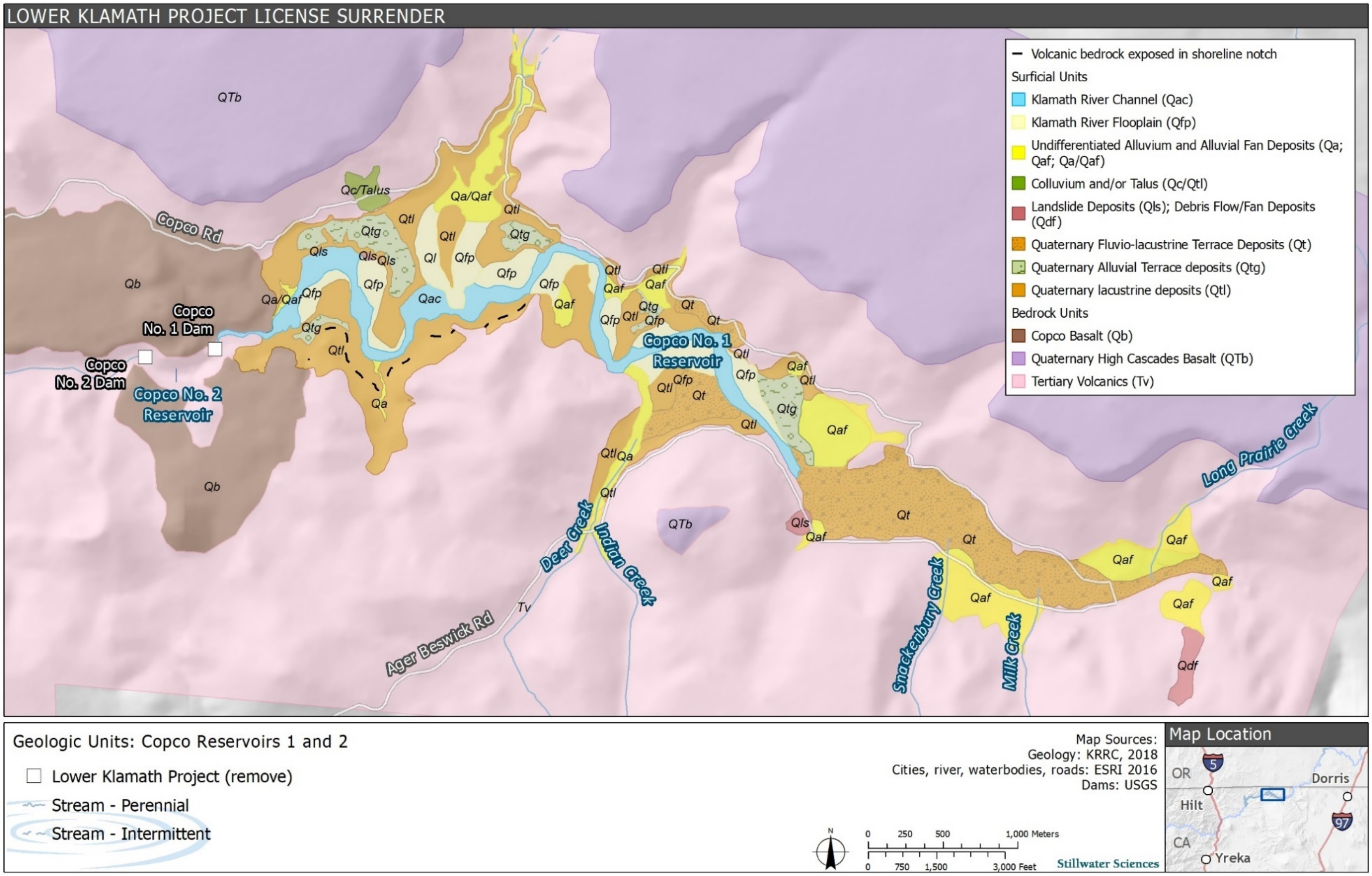

Figure 3.11-3. Surficial geology at Copco No. 1 Reservoir (Appendix B: *Definite Plan*).

Copco No. 2 Bypass Reach (RM 201.5 to 200.0)

Downstream of Copco No. 2 Dam, the Copco No. 2 Bypass Reach is a confined with minimal floodplain area. The average gradient of the bypass reach is about 1.9 percent. Bedrock channel reaches alternate with reaches where boulder-cobble deposits occupy most of the channel area. The Copco No. 2 Powerhouse returns flow to the Klamath River near RM 200.0 at the end of the reach (FERC 2007).

Iron Gate Reservoir and Tributaries (RM 200.0 to 193.1)

Iron Gate Reservoir overlies a slope break in the Klamath River valley profile, where a steeper upstream reach transitions to a lower gradient downstream reach. In this downstream reach, the valley widens and the channel is less confined by basalt flows (FERC 2007). Iron Gate Dam and its reservoir lie within Western Cascades geologic sub-province. Bedrock units include tuffaceous siltstones and sandstones, bouldery volcaniclastics and volcanic breccia, tuff and tuff breccia, and pyroxene flow rocks (Figure 3.11-4). Iron Gate Reservoir is relatively narrow and steep-sided, with numerous tributaries entering from the north (Fall Creek, Jenny Creek, Dutch Creek, Camp Creek, and Scotch Creek). Of these tributaries, Camp Creek and Jenny Creek supply the most sediment to the reservoir.

Iron Gate Dam to Hilt Mine (RM 193.1 to 184.0)

Downstream of Iron Gate Dam, the Klamath River flows through a narrow valley cut into the Western Cascade sub-province geology and sedimentary rocks of the Cretaceous Hornbrook Formation. The average gradient ranges from about 0.2 to 0.4 percent in the first five miles downstream of Iron Gate Dam. A narrow, discontinuous floodplain and extensive high terraces border the channel. The mostly single thread channel contains frequent bedrock outcrops, but the predominantly alluvial reaches have cobble-boulder bars and split flow around mid-channel bars with short side channels. Most of the bars are at least partially vegetated. The main tributaries entering this reach include Brush Creek, Bogus Creek, Little Bogus Creek, Willow Creek, and Cottonwood Creek. With the exception of Cottonwood Creek, these tributaries form relatively small, fine-grained alluvial fans at their confluences with the Klamath River. Cottonwood Creek forms a relatively large alluvial fan at its confluence near RM 185.1. Cottonwood Creek, Bogus Creek, and Little Bogus Creek are the first substantial sources of sediment downstream of Iron Gate Dam (Ayres Associates 1999, Buer 1981).

Hilt Mine to Indian Girl Mine (RM 184.0 to 177.2)

The Klamath River channel in this reach becomes more bedrock-dominated and confined within a narrow canyon. Alluvial bars are limited to the vicinity of the larger tributary confluences, such Williams Creek near RM 182.1 and the Shasta River near RM 179.5. The Shasta River is a source of fine gravel, sand, and finer sediment. However, the lack of substantial sedimentation in the vicinity of its confluence with the Klamath River suggests the Shasta River supplies little coarse sediment (Ayres Associates 1999).

Indian Girl Mine to Scott River (RM 177.2 to 145.1)

The channel in this reach of the Klamath River is mostly meandering and single thread, with valley width ranging from 300 feet to almost 1,200 feet. Sections with larger valley widths typically promote a lower gradient channel, more frequent alluvial features, and more

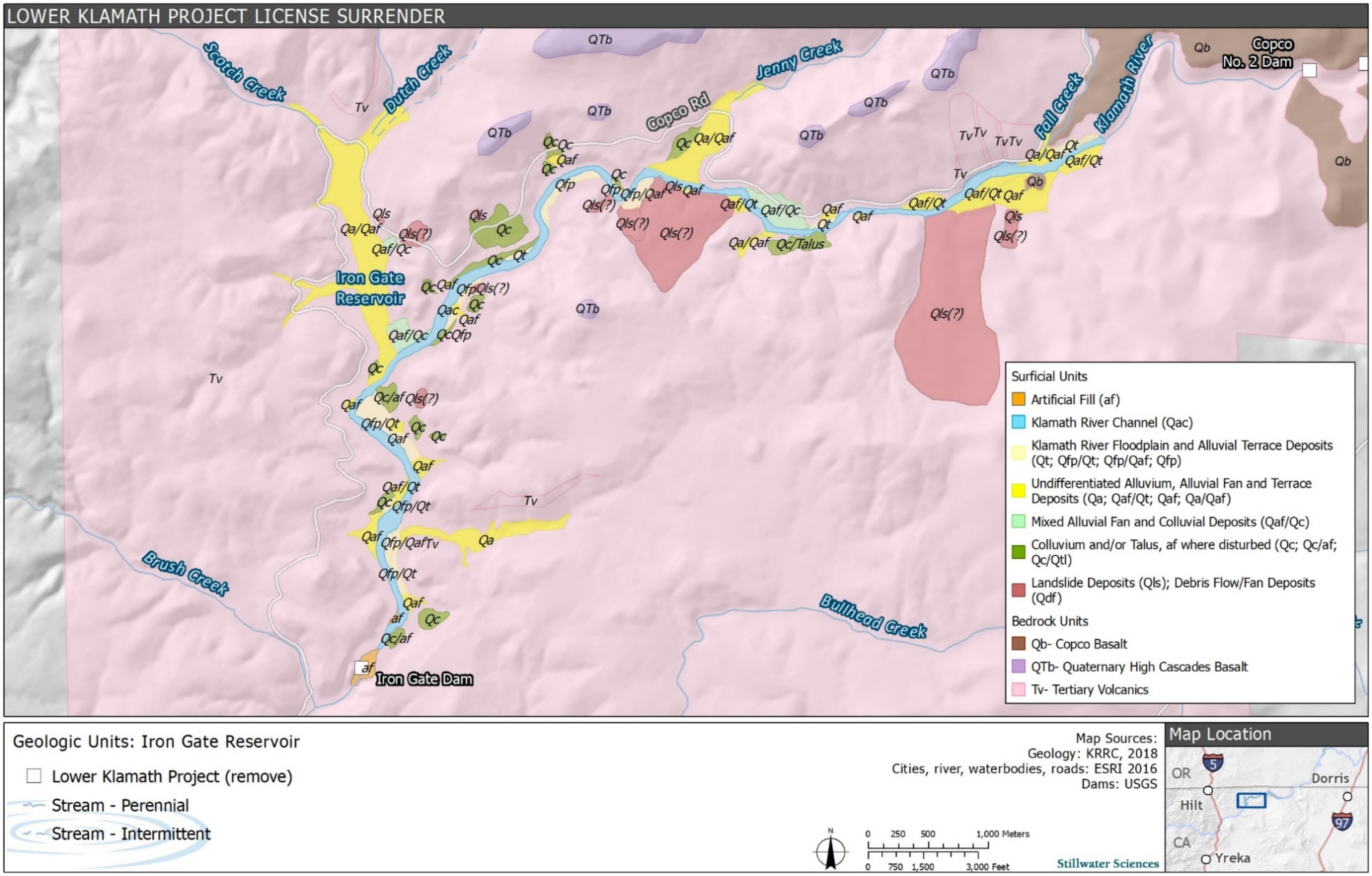

Figure 3.11-4. Surficial geology at Iron Gate Reservoir (Appendix B: *Definite Plan*).

extensive floodplains. Unvegetated point bars at the inside of channel bends, mid-channel bars, and side channel complexes are more prevalent in this reach. Alluvial features are largest in the areas immediately downstream of major tributary confluences and are typically smaller than about 17 acres per mile until after the Scott River confluence at RM 145.1. Terraces have been extensively mined throughout the reach, with tailings piles occurring in some floodplain areas.

From Miller Gulch (RM 163.8) to Horse Creek (near RM 149.7), the river valley broadens and includes terraces and gravel bars. A narrower section from between RM 156.3 and RM 152 is confined by bedrock and by the Kohl Creek alluvial fan. From RM 152 to Horse Creek (RM 149.6), the river valley widens and has been extensively placer mined, resulting in mine tailings and other floodplain disturbance.

From Horse Creek (RM 149.6) to Scott River(RM 145.1), the river valley narrows and is confined by bedrock. Terraces and bars are restricted to the inside of meander bends. Several small tributaries enter in this reach, forming steep alluvial fans at their confluence with the Klamath River. Channel morphology is single thread with few small and unvegetated mid-channel bars and point bars (USBR 2012).

Scott River to China Point (RM 145.1 to 119.8)

The Scott River is a major source of gravel and finer sediment to the Klamath River (Ayres Associates 1999). The prevalence, size, and height of unvegetated gravel bars increases downstream of the Scott River confluence (RM 145.1 to RM 133.8), with discontinuous narrow alluvial terraces forming along the canyon margins. At Seiad Valley (approximately RM 132.8), large alluvial fans from Seiad Creek, Little Grider Creek and Grider Creek form a wider alluvial valley in which terraces are cut on the front edges of the fans and the increased tributary sediment supply results in large bars and riffles. Extensive placer mining has occurred on floodplains and terraces within the Seiad Valley area.

From RM 131.4 to 123.3, the Klamath River flows through a bedrock canyon with unvegetated bars located on the inside of meander bends. Valley terraces and bars with bedrock at shallow depth are prevalent in this reach. From RM 123.3 to China Point (RM 119.8), the canyon narrows as it enters bedrock of the Jurassic Galice Formation. Bedrock benches form along the channel margins. At China Point, an extensive, unvegetated gravel bar lies on the inside of the bend along with a higher alluvial terrace. Tributaries that contribute sediment to the river in this reach include Thompson, Fort Goff, Portuguese, Grider, Walker, O'Neil, and Macks creeks (USBR 2012).

China Point to Trinity River (RM 119.8 to 43.3)

From China Point (RM 119.8) to Deason Flat (RM 106), the channel is narrow with numerous valley terraces that have been extensively mined. Well-developed bars and riffles occur at tributary confluences and meander bends. The lower three miles of this reach contain a greater number of unvegetated bars formed by sediment inputs from Elk and Indian creeks and channel constriction beginning at RM 105.6. Tributaries in this reach deliver large quantities of sediment from landslide sources.

From Deason Flat to Dutch Creek (RM 93), the river flows through a narrow bedrock canyon with low bedrock benches capped by thin gravel deposits. Wider sections interspersed in this reach have small valley terraces that have been extensively mined and have unvegetated gravel bars. This reach also contains notable landslides along the mainstem. Independence and Clear creeks both contribute large amounts of sediment to the Klamath River in this reach.

From Dutch Creek to the Trinity River (RM 43.3), the Klamath River is confined within a narrow bedrock canyon with intermittent alluvial reaches. This reach also includes the wider alluvial valley at Orleans (RM 59). Geomorphic features include valley terraces, alluvial fans, bedrock benches, and alluvial bars. Numerous landslides occur along the Klamath River and interact with the river by delivering sediment and controlling channel position. This reach is the downstream limit of mining on the Klamath River. Tributaries that are major contributors of sediment include Ukonom Creek, Camp Creek, Bluff Creek, and the Salmon River (USBR 2012).

Trinity River to the Pacific Ocean (RM 43.3 to 0)

From the Trinity River (RM 43.3) to Cappell Flat (RM 33), the Klamath River flows through a narrow bedrock canyon with few bars and no floodplain or terraces. The channel is primarily bedrock controlled. Landslides and alluvial fans are less common. The Trinity River is a major source of sediment (Ayres Associates 1999).

From Cappell Flat to Starwein Flat (RM 10), the river flows through a narrow, confined valley with minimal floodplain and terraces. Alternate bars form in straighter reaches and point bars form at meander bends. Split flow channels, mid-channel bars, and riffles commonly form in the vicinity of tributary confluences. Major sediment contributors include Blue, Pecwan, Cappell, Bear, and Tectah creeks.

From Starwein Flat to the mouth (RM10–0), the river transitions into a wide valley with floodplain surfaces and terrace remnants. Well-developed bars of variable height lie along the reach and several large pools and few riffles are present. Turwar Creek is the only major sediment producer in this reach, contributing mostly fine materials to the Klamath River (USBR 2012). The lower seven miles of the Klamath River are relatively narrow and confined, typically between 650 and 800 feet wide, with steeper gradient than in upstream reaches. The channel is up to 1,600 feet wide at large bends and in areas with active erosion and channel migration.

The mouth of the river is characterized by a delta with a large barrier bar parallel to the coastline. Landward of the barrier bar is a shallow estuary about 2,500 feet long by less than 1,000 feet wide. The Klamath River through the estuary is highly dynamic, changing positions during large flood events and transporting most of its suspended sediment load out to the ocean. The relatively small size of the estuary is maintained by ongoing deposition of medium grained sand and silty sand (USBR 2010a).

3.11.2.3 Slope Instability and Mass Wasting

Mass failures and other gravity-driven erosion processes can occur on relatively steep slopes. Such conditions within the soils and geology Area of Analysis exist only within the vicinity of the Klamath River Gorge from the California-Oregon state line to just downstream of Iron Gate Dam. Other areas of potential slope instability include all steep slopes underlain by consolidated volcanic ash (also known as tuff), as well as slopes of deep colluvium or talus that could produce slumps and debris flows. Continuous creep and rapid rockfall occur on and near talus slopes throughout the Klamath River Gorge.

Land surrounding J.C. Boyle Reservoir is generally low gradient and underlain by competent materials (Appendix B: *Definite Plan*). Rock fall from steep talus slopes is prevalent along the Klamath River between J.C. Boyle Dam and Copco No. 1 Reservoir.

Undifferentiated surficial deposits occur around much of Copco No. 1 Reservoir. These deposits include talus and rockfall debris, alluvium and alluvial fans associated with tributary drainages, and alluvial and lacustrine terrace deposits. No large-scale landslides have been identified in either the terrestrial or subaqueous slopes around Copco No. 1 Reservoir (Appendix B: *Definite Plan*), although a large alluvial fan or colluvial deposit on the north side of Copco No. 1 Reservoir may be related to an ancient inactive landslide (PanGEO 2008) (Figure 3.11-3). Wave action at the Copco No. 1 Reservoir shoreline has eroded sand and volcaniclastic tuff beneath diatomite beds, creating up to 10- to 20-ft-high vertical exposures.

PanGEO (2008) identified three possible old landslide-related features that occur on the south rim of Iron Gate Reservoir (Figure 3.11-4). KRRC identified another likely landslide along Copco Road within the peninsula between the east and west arms of Iron Gate Reservoir (Appendix B: *Definite Plan*).

Channel boundaries in the vicinity of the Lower Klamath Project are prominently composed of bedrock, boulders, and cobble, and thus subject to only minor erosion. Bank erosion is therefore not a substantial sediment source.

3.11.2.4 Sediment Load

Sediment is supplied to stream channels through mass wasting (landslides, debris flows, earthflows), sheetwash, gullying, bank failure, fluvial erosion (bank erosion, channel avulsion), dry ravel (loss of cohesion in surface materials), tree throw, wind erosion, animal action (e.g., burrowing), and soil creep. Sediment supply to the Klamath River has been estimated for portions of the Klamath Basin through various methods, including field inventory of sediment sources, interpretation of air photos and other historical information, estimation of reservoir sediment accumulation, and modeling based on empirical sediment delivery rates for specific geomorphic terrains. Primary sources of existing information about sediment delivery to the Klamath Basin include the following:

- Assessment of the quantity and characteristics of sediment stored in Iron Gate, Copco No. 1, and J.C. Boyle reservoirs (GEC 2006, USBR 2012);
- The sediment budget developed by PacifiCorp and submitted to FERC as part of the final license application for the Klamath Hydroelectric Project (FERC No. 2082) (PacifiCorp 2004);
- Sediment source inventories conducted in support of sediment TMDLs in the Scott River, Trinity River, and South Fork Trinity River sub-basins (USEPA 1998, 2001; North Coast Regional Board 2005);
- The Salmon Sub-basin Sediment Analysis (de la Fuente and Haessig 1993);
- Cumulative watershed effects analyses and watershed analyses conducted for federal lands administered by the Forest Service (UDSA Forest Service 2003, 2004, 2005; Elder 2005, 2006); and
- Sediment source inventories conducted on industrial timberlands (Simpson Resource Company 2002).

Existing information on sediment loads delivered to the Klamath River was combined with extrapolated estimates of sediment delivery from data-deficient source areas to derive estimates of cumulative average annual sediment delivery in the Klamath River from Keno Dam (RM 237) to the Pacific Ocean (RM 0) and the proportion of coarse material and fine material within the load (Stillwater Sciences 2010) (Table 3.11-3). Upper Klamath Lake traps most sediment entering the lake, and therefore little sediment is supplied to the Klamath River from the watershed upstream of Keno Dam. The average annual sediment delivery from Keno Dam to Iron Gate Dam was estimated to be approximately 150,000 tons/yr. The Scott River supplies approximately 607,000 tons/yr, the Salmon River 320,000 tons/yr, and the Trinity River 3,300,000 tons/yr. The cumulative average annual sediment delivery from the Klamath River to the ocean was estimated to be 6,237,500 tons/yr. The cumulative average annual delivery of sediment with a particle size greater than 0.063 mm (coarse sediment) was estimated to be 1,970,200 tons/yr. This estimate is within about 20 percent of Willis and Griggs (2003) estimate of average annual coarse sediment flux from the Klamath River to the Pacific Ocean (2,502,200 tons/yr). These estimates are based on various data sources encompassing different time periods and do not account for transfer of sediment to and from storage nor attrition.

Table 3.11-3. Estimated Annual Sediment Delivery to the Klamath River.

Source Area	River Mile	Cumulative delivery[1] (tons/year)		
		Total	≥0.063 mm	≤0.063 mm
Keno Dam to Iron Gate Dam	193.1	151,000	24,160	126,840
Iron Gate Dam to Cottonwood Creek	185.1	160,961	25,754	135,207
Cottonwood Creek	185.1	175,560	30,426	145,135
Cottonwood Creek to Shasta River	179.5	177,715	31,115	146,600
Shasta River	179.5	199,259	38,009	161,250
Shasta River to Beaver Creek	163.4	231,710	48,393	183,316
Beaver Creek	163.4	279,869	63,804	216,065
Beaver Creek to Scott River	145.1	373,073	93,630	279,443
Scott River	145.1	980,393	287,972	692,421
Scott River to Grider Creek	132.1	1,048,860	309,881	738,978
Grider Creek to Indian Creek	108.3	1,099,934	326,225	773,709
Indian Creek	108.3	1,173,246	349,685	823,561
Elk Creek	107.1	1,211,930	362,064	849,866
Clear Creek	100.1	1,253,972	375,517	878,454
Dillon Creek	85.4	1,282,389	384,611	897,778
Indian Creek to Dillon Creek	85.4	1,354,759	407,769	946,990
Dillon Creek to Salmon River	66.3	1,440,282	435,137	1,005,146
Salmon River	66.3	1,760,904	537,736	1,223,169
Salmon River to Camp Creek	57.3	1,785,769	545,693	1,240,077
Camp Creek	57.3	1,923,108	589,641	1,333,467

Source Area	River Mile	Cumulative delivery[1] (tons/year)		
		Total	≥0.063 mm	≤0.063 mm
Camp Creek to Red Cap Creek	52.9	1,946,606	597,160	1,349,446
Red Cap Creek	52.9	2,063,374	634,526	1,428,848
Red Cap Creek to Bluff Creek	49.7	2,079,504	639,687	1,439,816
Bluff Creek	49.7	2,417,974	747,998	1,669,976
Bluff Creek to Trinity River	43.3	2,439,210	754,793	1,684,416
Trinity River	43.3	5,756,544	1,816,340	3,940,204
Blue Creek	16.2	5,859,351	1,849,239	4,010,112
Trinity River to Mouth	0.0	6,237,471	1,970,237	4,267,234

Source: Adapted from Stillwater Sciences 2010.
[1] Cumulative sediment delivery is reported for the downstream endpoint of the corresponding source area identified in the first column. Mass is reported in US short tons and assumes a density of 1.5 tons/yd^3. Above Cottonwood Creek, assumes 16 percent of total load is ≥0.063 mm based on grain size distribution of reservoir sediment (Gathard Engineering Consulting 2006). Below Cottonwood Creek, assumes 10 percent of total load is bedload and 24 percent of suspended load is sand ≥0.063 mm.

The sediment load supplied from the watershed in any given year will vary from the long-term annual average load based on annual hydrologic conditions and other environmental factors (e.g., mass wasting, wildfire, land use) that control sediment supply and transport. Quantifying the potential annual variations around the estimated average annual sediment supply in the entire Klamath River basin is difficult without long-term data sets describing suspended or total sediment load. However, analyzing historical sediment discharge data from nearby locations provides a reasonable indication of the potential variation and trends in annual sediment supply. Janda and Nolan (1979) summarize sediment discharge data from a variety of USGS gaging stations in Northern California, including the Klamath River watershed. The highest annual sediment yield (Water Year [WY] 1974) in the Klamath River at Orleans was three times greater than the period average (WY 1968–1977). The highest annual sediment yield (WY 1964) in the Trinity River at Hoopa was a factor of seven greater than the period average (WY 1957–1977) and a factor of 14 greater than the estimated long-term annual average (Janda and Nolan 1979). The period of record for the Trinity River at Hoopa includes the large flood of 1964, whereas the period of record for the Klamath River at Orleans does not. Using these observed variations in annual sediment discharge as indicators for the expected range of potential variability in annual background sediment loads, the predicted sediment release from removal of dams on the Klamath River is within the typical range of background conditions at Scott River during years with average sediment delivery and as far upstream as Beaver Creek during years with high sediment delivery.

Additional insight is gained by comparing the average annual basin sediment delivery and the anticipated annual sediment load from dam removal with daily suspended sediment loads observed during large floods. The daily suspended sediment load measured in the Klamath River at Orleans exceeded the estimated cumulative average annual basin sediment delivery at the Salmon River confluence (sediment delivery node nearest Orleans) for five days during the period from WY 1968 to WY 1979. The highest daily suspended sediment load in the Klamath River at Orleans during the January 1974 flood (second largest during the 81 year period of record) was greater than the median estimate of total annual sediment load released by dam removal. Suspended sediment flux in the Trinity River at Hoopa from December 22 to 26, 1964 was approximately 25,400,000 tons, nearly eight times the high estimate of total annual sediment release from dam removal. During three of the days during the 1964 flood, the daily suspended sediment flux exceeded the high estimate of total annual sediment release from dam removal. Observations from these gaging records indicate that the predicted amount of sediment released by removal of dams on the Klamath River could be considered equal or less than the background sediment flux over a single day at the Salmon River confluence during large flood events (e.g., the January 1974 flood).

The coarse sediment deficit resulting from sediment trapping in the Lower Klamath Project developments has resulted in coarsening of the channel bed and a reduction in the size and frequency of mobile coarse sediment deposits in a limited downstream channel extent. Because tributaries downstream of Cottonwood Creek supply most of the coarse sediment to the mainstem Klamath River under both unimpaired and current conditions, the effects of reservoir sediment trapping are most apparent in the reach between J.C. Boyle Reservoir and approximately the Scott River. Reduced coarse sediment delivery to this reach has reduced the amount and quality of spawning gravel deposits and disrupted the geomorphic processes that create and maintain aquatic habitats (Buer 1981, PacifiCorp 2004). In response to this condition, the California Department of Water Resources developed (but never implemented) gravel augmentation programs for spawning gravel downstream from Iron Gate Dam (Buer 1981). Per the interim operations of the Klamath Hydroelectric Project HCP (PacifiCorp 2012), PacifiCorp developed and implemented a plan to augment gravel immediately downstream of Iron Gate Dam beginning in 2014 (PacifiCorp 2014). Gravel augmentation occurred immediately downstream of Iron Gate Dam in 2014, 2016, and 2017, with approximately 4,600 cubic yards total placed downstream of the dam as of December 2017 (PacifiCorp 2018). The placed gravel has been moved downstream by high flows (PacifiCorp 2018), although additional details on the extent of downstream movement have not been reported. Appendix F assesses the changes to bedload sediment within the soils and geology Area of Analysis for existing conditions and for the Proposed Project.

USBR (2010b) used reach average hydraulic properties and grain size data from previous studies to estimate the flow magnitude and return period at which sediment mobilization occurs downstream of Iron Gate Dam. The representative particle diameters for all data collected downstream of Iron Gate Dam are given in Figure 3.11-5. The estimates did not include the reach from Iron Gate Dam to Bogus Creek, for which there were no grain size data. USBR (2010b) assumed this reach to be fully armored because reservoir trapping has eliminated coarse sediment supply to the reach during the past 50 years. Flows required to initiate mobilization of the median grain size (D_{50}) in reaches downstream of Bogus Creek are summarized in Figure 3.11-6.

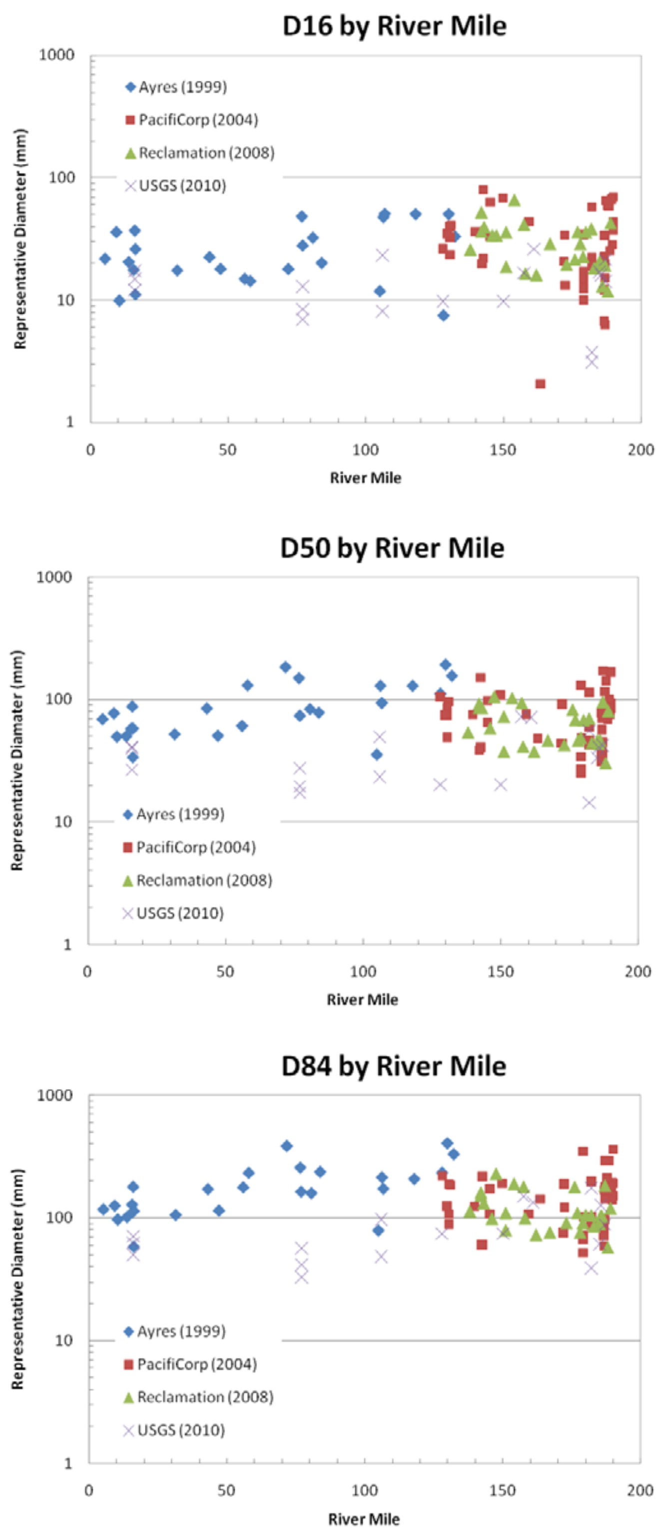

Figure 3.11-5. Particle Size Parameters (D_{16}, D_{50}, and D_{84}) from Pebble Counts of the Klamath River Bed Surface Downstream of Iron Gate Dam (USBR 2012).

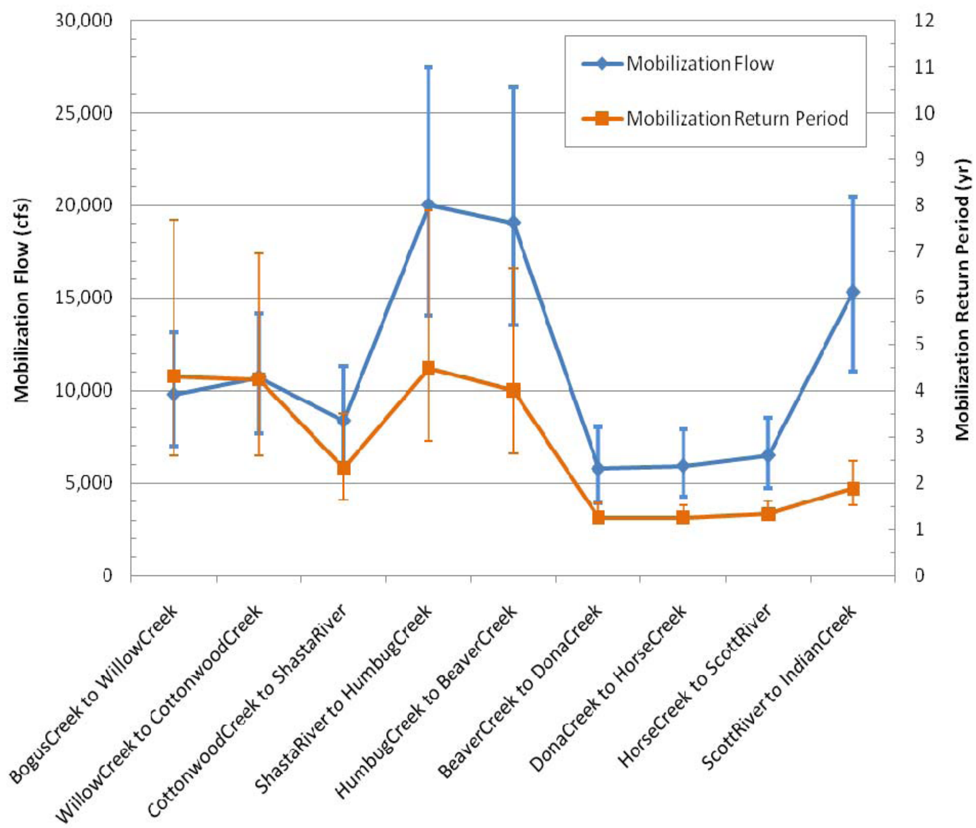

Figure 3.11-6. Flow and Corresponding Return Period at which Bed Mobilization Begins Under Existing Conditions (USBR 2012).

Suspended sediment data were collected by USGS at its gauges on the Shasta River near Yreka from 1957 to 1960, and on the Klamath River at Orleans from 1957 to 1979 and at Klamath from 1974 to 1995. The data show that suspended sediment concentrations commonly exceed 1,000 mg/L at Orleans, even at flows as low as 20,000 cfs (USBR 2012). Suspended sediment concentrations in the Klamath River upstream and downstream of Iron Gate Dam under existing conditions are summarized in Section 3.2.2.3 *Suspended Sediments* and in Appendix C.

The Scott River, mainstem Trinity River, South Fork Trinity River, and Klamath River downstream of the Trinity River confluence at Weitchpec are listed as sediment impaired under Section 303(d) of the federal CWA. Sediment source analyses, TMDL allocations for sediment, and sediment TMDL implementation plans have been completed for the Scott River, Trinity River, and South Fork Trinity River basins. A sediment source analysis and sediment TMDL have not been completed for the Klamath River downstream of the Trinity River confluence. The North Coast Regional Water Quality Control Board (North Coast Regional Board) adopted a regional sediment TMDL implementation policy for the Klamath River downstream of the Trinity River (Resolution R1-2004-0087 on 29 November 2004), and no additional sediment sources analyses are scheduled to be conducted in the basin.

3.11.2.5 Reservoir Sediment Storage and Composition

The four Lower Klamath Project reservoirs currently store approximately 13.15 million cubic yards (yd^3) of sediment (USBR 2012). The volume and weight of sediment stored in each reservoir is given in Table 3.11-4. The distribution of sediment deposits varies within each of the reservoirs. In J.C. Boyle Reservoir, sediment primarily resides in the area nearest to the dam, with thicknesses up to 20 ft (Figure 3.11-7). Both Copco No. 1 and Iron Gate reservoirs have generally even distributions of sediment with thicknesses increasing towards the dams (Figure 3.11-8 and Figure 3.11-9). The maximum thickness of the Copco No. 1 Reservoir sediment is approximately 10 ft. The maximum deposition within the thalweg of Iron Gate Reservoir is around 5 ft, with nearly 10 ft of deposition in the Jenny Creek arm of the reservoir. Copco No. 2 Reservoir inundates a small area extending to the base of Copco No. 1 Dam has no sediment sources, and does not retain appreciable amounts of sediment (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

Table 3.11-4. Sediment stored in Lower Klamath Project reservoirs, Fall 2009.

Reservoir	Total Sediment Volume[1] (yd^3)		Total Sediment Mass[2,3] (tons)	Fine Sediment Mass[2,4] (tons)	Sand Sediment Mass[2,5] (tons)	Percent Fine Sediment by Mass[7]	Percent Sand Sediment by Mass[7]
J.C. Boyle	990,000	+/- 300,000	290,000	190,000	100,000	66 percent	34 percent
Copco No. 1[6]	7,440,000	+/- 1,500,000	1,880,000	1,630,000	260,000	86 percent	14 percent
Iron Gate[6]	4,710,000	+/- 1,300,000	1,430,000	1,210,000	230,000	84 percent	16 percent
Total[6]	13,150,000	+/- 2,000,000	3,600,000	3,020,000[6]	590,000	84 percent	16 percent
Total Copco No. 1 and Iron Gate[6]	12,150,000	+/- 2,000,000	3,320,000	2,830,000[6]	490,000	85 percent	15 percent

Source: Modified from USBR 2012a, as noted in the below footnotes.
1 Uncertainty resulted from interpolation between drill holes and is calculated as a volume with a +/- amount shown in the table (USBR 2012a).
2 Amount of sediment with a diameter greater than 2 millimeters is negligible (< 0.5 percent) for all the reservoirs and within the uncertainty of the sediment estimates. Ton is defined as equal to 2,000 pounds (dry weight).
3 Average dry densities vary between reservoirs and within the reservoir depending upon compaction and grain size distribution. The dry unit weight varies between 44.4 and 16.3 lb/ft^3 (USBR 2012a).
4 Fine sediment is sediment with a diameter less than 0.063 millimeters
5 Sand sediment is sediment with a diameter between 0.063 and 2 millimeters
6 Amounts of sediment (volumes and masses) from individual reservoirs may not equal the total amounts indicated because all volumes and masses taken from USBR (2012a) were rounded to the nearest 10,000 yd^3 (volume) or 10,000 tons, dry weight (mass). Copco No. 2 Reservoir does not retain measurable amounts of sediment and therefore is not included in the estimates of total stored sediment.
7 Percent sediments are calculated from the masses listed in the table and rounded so the percent fine sediment and the percent sand sediment sum to 100 percent.

Sediment in the Lower Klamath Project reservoirs is primarily composed of elastic silt and clay (fine sediment), including silt-size particles of organic material such as algae and diatoms, with lesser amounts of cobble and gravel (coarse sediment) (Table 3.11-5) (USBR 2012). The fine-grained sediment has low cohesion and is erodible (USBR 2010a).

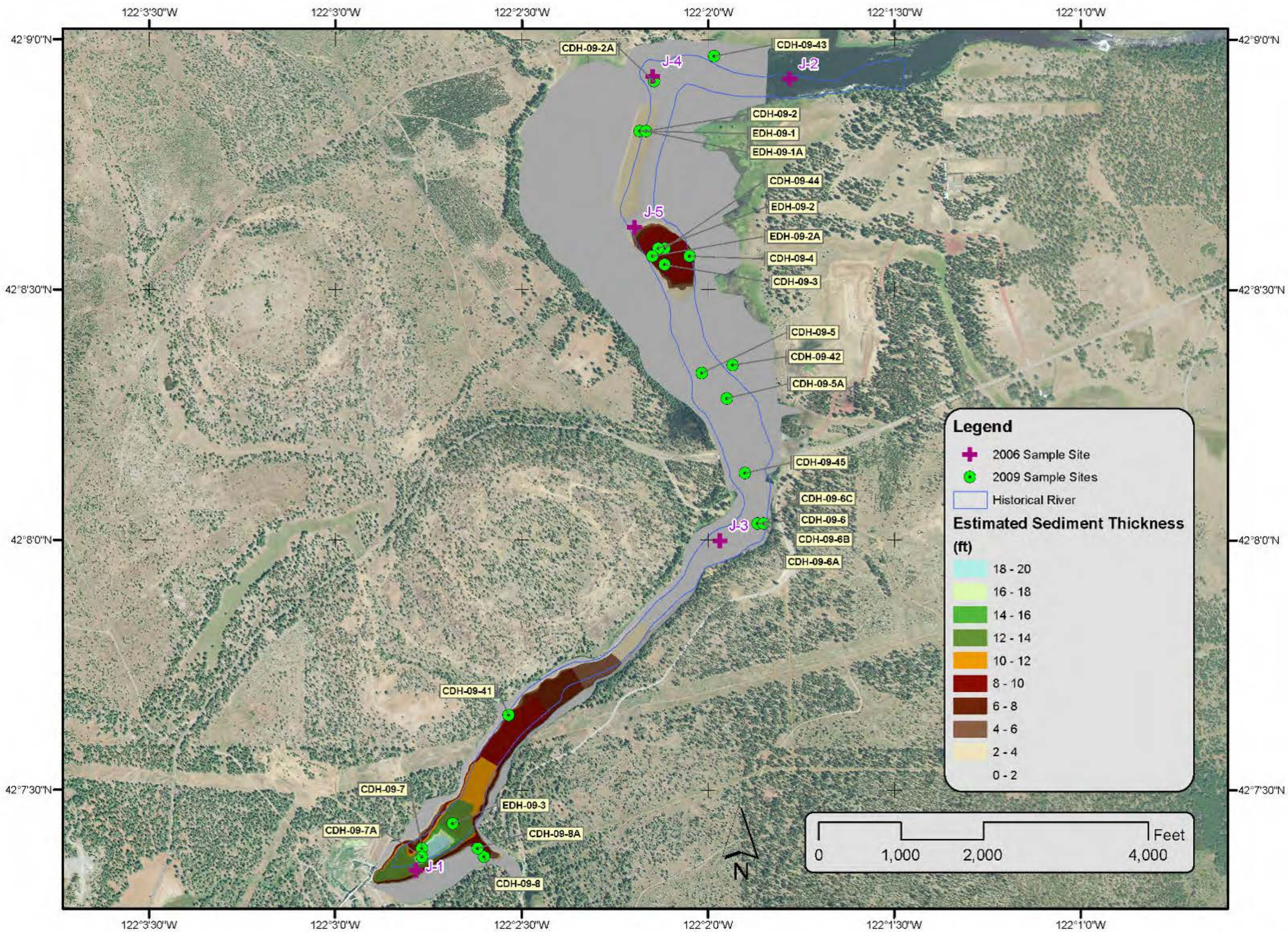

Figure 3.11-7. J.C. Boyle Reservoir Estimated Sediment Thickness and Sample Site Locations.

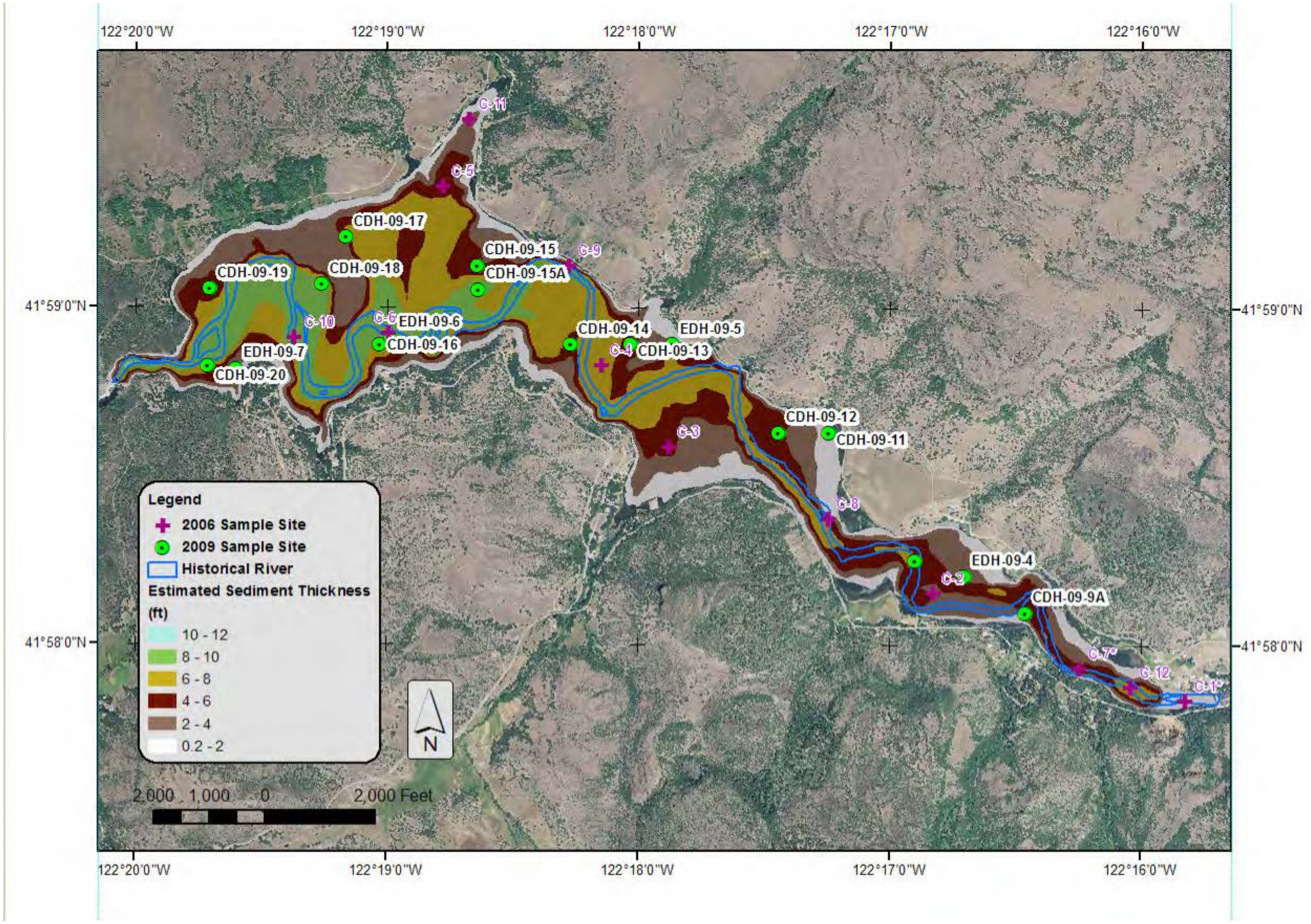

Figure 3.11-8. Copco Reservoir Estimated Sediment Thickness and Sample Site Locations.

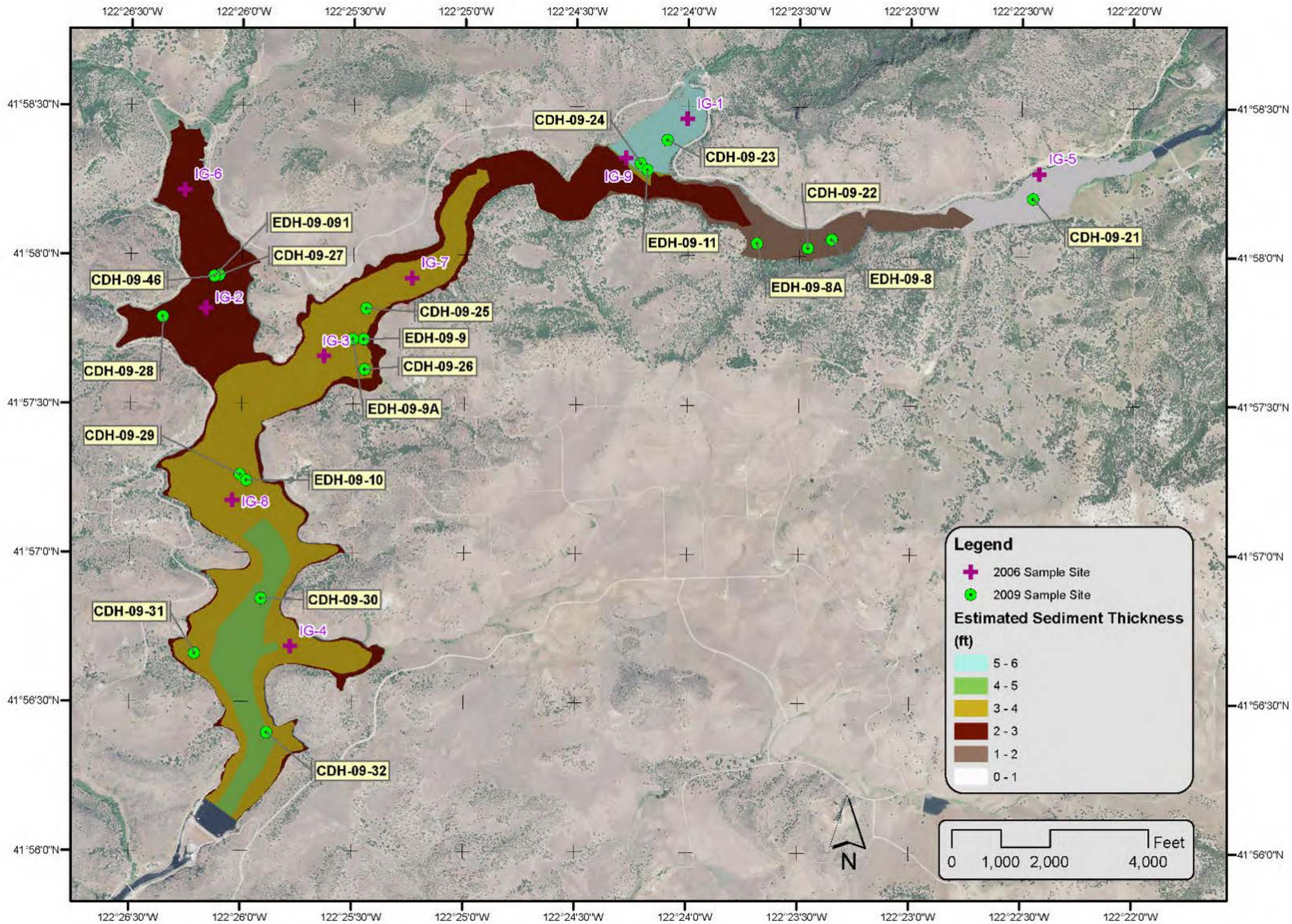

Figure 3.11-9. Iron Gate Reservoir Estimated Sediment Thickness and Sample Site Locations.

Table 3.11-5. Physical Properties of Reservoir Sediment.

Reservoir	Location	Volume yd³	percent Clay[1]	percent Silt[1]	percent Sand[1]	percent Gravel[1]	Liquid Limit (percent)	Plasticity Index (percent)	Moisture Content (percent)	Porosity (percent)	Dry Bulk Density lb/ft
J.C. Boyle	Upper Reservoir	380,000	17.3	26.2	56.5	0.0	45.5	14.7	173	0.82	29.5
	Lower Reservoir	620,000	38.2	49.7	12.1	0.0	173	60.6	345	0.90	16.3
	Pre-reservoir	–	3.7	9.5	28.4	58.5	44.9	12.7	23.4	0.38	101
Copco No. 1	Upper Reservoir	810,000	27.9	46.8	25.1	0.2	109.3	49.3	287	0.88	19.2
	Lower Reservoir	6,630,000	55.8	34.2	10.0	0.0	154.3	59.1	295	0.88	18.7
	Pre-reservoir	–	35.6	42.2	22.2	0.0	105.0	41.5	153	0.80	32.6
Iron Gate	Upper Reservoir	830,000	35.4	43.1	21.6	0.0	70.9	29.9	192	0.83	27.0
	Lower Reservoir	2,780,000	60.7	25.5	13.5	0.4	118.7	51.4	276	0.88	19.8
	Pre-reservoir	–	33.6	16.9	20.4	29.1	60.6	32.5	37.9	0.50	81.8
	Upper Tributary	300,000	31.8	42.7	25.5	0.0	60.7	22.7	102	0.73	44.4
	Lower Tributary	800,000	61.8	32.0	6.1	0.0	112.2	49.6	284	0.88	19.3

Source: USBR 2010a, 2012.

[1] Clay = 0 to 0.005 mm; Silt and very fine sand = 0.005 to 0.075 mm; Sand = #200 to #4 sieve; Gravel = #4 to 3 inch. Note that while organic material such as algae and diatoms would be associated with the clay and/or silt classes in the reservoir sediments, the standard method used for size separation (ASTM D22) in USBR (2012) would remove a small fraction of these during sample drying at 110ºC.

Key:
yd³: cubic yards
lb/ft: pounds per foot

3.11.3 Significance Criteria

For the Lower Klamath Project EIR, impacts to geology and soils would be considered significant if Proposed Project implementation would result in any of the following:

- Substantial soil erosion from upland areas into the reservoirs or the Klamath River due to project construction activities.
- New or exacerbated mass wasting around the rim of the reservoirs during drawdown.
- Substantial deposition of sediment in the Klamath River channel or Klamath estuary due to erosion of reservoir sediment deposits.
- Long-term removal of access to mineral resources for extraction.
- Exposure of people or structures to adverse effects resulting from rupture of a known earthquake fault, strong seismic ground shaking, volcanic activity, or large-scale slope instability.

For the purposes of this EIR, substantial is defined as "of considerable importance to public health and safety, water quality, and/or physical conditions supporting aquatic resources as these resources pertain to geology and soils." Additional criteria related to geology and soils associated effect to other resources is addressed in Section 3.2 *Water Quality*, Section 3.3 *Aquatic Resources*, and Section 3.6 *Flood Hydrology* of this EIR.

3.11.4 Impacts Analysis Approach

The assessment of the environmental impacts on geology and soils focuses on whether changes to geomorphology and sediment transport resulting from implementation of the Proposed Project would substantially increase erosion or mass wasting, or result in substantial sediment deposition which could adversely affect other associated resources within the soils and geology Area of Analysis. The soils and geology impact analysis uses results from the analyses described below to determine changes in bed elevation, substrate composition, and fine sediment deposition under the Proposed Project. Potential geomorphic changes associated with dam removal activities are described qualitatively.

Bedload transport in the area upstream of the influence of J.C. Boyle Reservoir is not anticipated to be affected by the Proposed Project (i.e., dam removal), is not within California, and is not evaluated further in this document. Link and Keno dams would remain in place and would continue to affect hydrology and sediment transport as occurs under existing conditions.

The following sources were assessed to determine the scope of existing local policies relevant to the Proposed Project:

- Del Norte County General Plan (Mintier & Associates et al. 2003):
  - Soil Resources, Policy 1.D.5
- Humboldt County General Plan for Areas Outside of the Coastal Zone (Humboldt County 2017):
  - Chapter 10.3.4, Policies BR-S8 and BR-S9
  - Chapter 11, Policies WR-P10, WR-P42, WR-P42, WR-S7, WR-IM3, WR-IM32

- Klamath County Comprehensive Plan (Klamath County 2010):
  - Goal 5 (Open Space, Scenic, and Historic Area and Natural Resources), Policy 16
- Siskiyou County General Plan (Siskiyou County 1980):
  - Geologic Hazard, Policies 1, 2, 3, 5, and 6
  - Erosion Hazard, Policy 7

Most of the aforementioned policies (and objectives) are stated in generalized terms, consistent with their overall intent to protect geologic and soil resources. By focusing on the potential for impacts to geologic and soil resources within the Area of Analysis, consideration of the more general local policies listed above is inherently addressed by the specific, individual analyses presented in Section 3.11.5 *[Geology, Soils, and Mineral Resources] Potential Impacts and Mitigation*. The more general local policies are not discussed further.

3.11.4.1 Flows

Flows under the Proposed Project were modeled assuming Klamath River hydrology defined by KBRA operations of the Klamath Irrigation Project (USBR 2012). As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, the KBRA has expired, and hydrology under the Proposed Project would be pursuant to the 2013 BiOp (NMFS and USFWS 2013). As detailed in Section 3.1.6, the 2013 BiOp provides similar flow releases to KBRA, and does not alter the key hydrological factors that drive model results, including timing, frequency, and magnitude of flows released during winter and spring.

3.11.4.2 Suspended Sediment

USBR (2012) analyzed the potential effects of the Proposed Project on suspended sediment concentration (SSC) using output from the One Dimension Version (2.4) of the Sedimentation and River Hydraulics sediment transport model (SRH-1D). SRH-1D provided estimates of daily average SSCs at different points in the river (Huang and Greimann 2010, as summarized in USBR 2012) (see also Appendix E of this EIR). Existing conditions were also simulated using the SRH-1D model, to provide a comparison of what SSCs would be under existing conditions or under the Proposed Project in the years 2020 and 2021. Modeling assumed the Proposed Project occurred within the 48-year period beginning in 1961.

3.11.4.3 Bedload Sediment

USBR (2012) also analyzed potential changes to bedload sediment using output from the SRH-1D model (Huang and Greimann 2010, USBR 2012) (see also Appendix F of this EIR). Short-term (2-year) and long-term (5-, 10-, 25-, 50-year) changes in bedload were evaluated for a range of hydrologic conditions using representative flows taken from historical hydrology. A long-term simulation was not conducted for the Klamath River upstream of Iron Gate Dam under the assumption that short-term bedload sediment conditions (i.e., at the end of 2 years) are representative of long-term bedload sediment conditions (USBR 2012).

3.11.5 Potential Impacts and Mitigation

Potential Impact 3.11-1 Reservoir drawdown could result in changes to geologic hazards, such as seismic or volcanic activity.
As described in Section 3.11.2 *Environmental Setting*, the Lower Klamath Project is within an area that has historically been seismically active. The nearest active fault is approximately five miles from the dams proposed for removal. These faults are reported not to have moved within the past 1.5 million years and, therefore, are considered inactive (Personius et al. 2003). Under the Proposed Project, the four developments within the Lower Klamath Project would be removed as described in Section 2 *Proposed Project*. Sediment currently held behind the dams would be released during the same period. Although reservoir filling can induce seismicity, drawdown of reservoirs of this size is not expected to induce seismicity. Reservoir draining is also not expected to cause volcanic activity due to the distance from volcanic hazards (e.g., Mount Shasta). No new structures would be constructed in the Area of Analysis for geology and soils following removal of the four developments, thus there would be little to no immediate risks from changes to geologic hazards to people and infrastructure.

Significance
No significant impact

Potential Impact 3.11-2 Soil disturbance associated with heavy vehicle use, excavation, and grading could result in erosion during removal activities.
Soil disturbance associated with heavy vehicle use, excavation, and grading could result in erosion during removal activities at Iron Gate and J.C. Boyle reservoirs and could exacerbate existing erosion at Copco No. 1 Reservoir. Prior to demolition, coverage under the General Stormwater National Pollution Discharge Elimination System Permit for Construction Activities in both Oregon and California would be required as per Section 402 of the Clean Water Act. Coverage under this permit requires the development and implementation of an Erosion Control Plan prior to deconstruction that describes BMPs to prevent erosion during demolition activities. These BMPs would be implemented in accordance with the approved Storm Water Pollution Prevention Plan (SWPPP) and Erosion Control Plan (Appendix B: *Definite Plan*). Implementation of these BMPs under the Proposed Project would minimize the potential for erosion and sediment delivery into the reservoir areas.

Significance
No significant impact

Potential Impact 3.11-3 Reservoir drawdown could result in hillslope instability in reservoir rim areas.
The KRRC proposes drawdown of J.C. Boyle, Copco No. 1, and Iron Gate reservoirs would take place between November 1 of dam removal year 1 and March 15 of dam removal year 2 as detailed in the proposed Reservoir Drawdown and Diversion Plan (Appendix B: *Definite Plan*). For all reservoirs, the minimum drawdown rate would be 2 feet per day and the maximum drawdown rate would be 5 feet per day, until drained. Although the new gates at Copco No. 1 and Iron Gate dams would be able to accommodate higher drawdown rates, the maximum drawdown rate of 5 feet per day is recommended by KRRC as a conservative value based upon slope stability analyses conducted for each of the Lower Klamath Project reservoirs.

The area surrounding J.C. Boyle Reservoir is generally low gradient and underlain by competent materials. Review of topographic data and reconnaissance of the reservoir slopes indicate that no landslides occur adjacent to the reservoir. For these reasons, the stability of the J.C. Boyle Reservoir slopes would be unaffected by the reservoir drawdown and there would be no impact due to the Proposed Project.

No large scale landslides have been identified in the terrestrial or subaqueous slopes around Copco No. 1 Reservoir. Diatomaceous deposits along the rim and below the reservoir water level present the greatest potential for slope instability during drawdown (Appendix B: *Definite Plan*). Where the toe of the diatomite deposit lies above the current high lake level, slope response to rapid drawdown is determined by the properties and geometry of the underlying volcanic and volcaniclastic strata. Where the toe of the diatomite deposit lies below the current high lake level, slope response to rapid reservoir drawdown is determined by the properties and thickness of the diatomite deposits and the underlying material. Based on the low diatomite permeability, the proposed drawdown rate (2 to 5 feet per day) would have minimal effect on its stability. KRRC is therefore not proposing to limit the drawdown rate of Copco No. 1 Reservoir.

The geologic assessment and slope stability analysis conducted by KRRC (Appendix B: *Definite Plan*) indicated that certain segments along the Copco No. 1 Reservoir rim have a potential for slope failure that could impact existing roads and/or private property (Figure 3.11-10). These areas include approximately 3,700 linear feet of slopes along Copco Road and approximately 2,800 linear feet of slope adjacent to private property (Appendix B: *Definite Plan*). Up to eight parcels in these areas have existing habitable structures that could potentially be impacted. KRRC has proposed to complete additional field geologic investigation and laboratory testing of material properties to better understand the potential for slope instability in these areas.

As part of the Proposed Project, KRRC would consider the following actions to offset potential impacts in reservoir rim areas where there is a high probability of slope failure (Appendix B: *Definite Plan*):

1. For segments along Copco Road:
    a. Re-align road segment away from rim slope
    b. Engineer structural slope improvements (e.g., drilled shafts or other structural elements that could be installed to resist slope movement)
2. For segments adjacent to property or structure:
    a. Move structure or purchase property
    b. Engineer structural slope improvements (e.g., drilled shafts or other structural elements that could be installed to resist slope movement)

While the proposed actions is designed to reduce the potential for new or exacerbated mass wasting around the rim of the reservoirs associated with drawdown, the proposed actions do not explicitly address potential impacts resulting from hillslope instability outside of those areas currently identified as having a high probability of slope failure or commit KRRC to implementation of their aforementioned proposed actions. Therefore, the impact of the project on hillslope instability in reservoir rim areas would be significant.

Implementation of Mitigation Measure GEO-1 would reduce the impact of slope failure in reservoir areas to less than significant. If instability of these deposits exposes cultural resources, then the impact may be significant and mitigation may be required (see Section 3.12.5 *[Historical Resources and Tribal Cultural Resources] Potential Impacts and Mitigation*).

The extent and morphology of bedrock outcrops and general lack of surficial deposits around Iron Gate Reservoir suggest stable reservoir slopes under rapid drawdown conditions (Appendix B: *Definite Plan*). There may be potential for drawdown to induce block sliding where hard, strong volcanic flow rocks are underlain by saturated tuffaceous beds and bedding dips into the valley (PanGEO 2008). Hammond (1983) reports several low to moderate dip angles of volcaniclastic beds into the valley, but there is no evidence of previous slope instability at these locations. Historical aerial photographs indicate that the three possible old landslide-related features that occur on the south rim of Iron Gate Reservoir have been stable and unaffected by historical reservoir drawdowns and have a low risk of instability during future drawdown (Appendix B: *Definite Plan*). Shallower slides are likely to occur in the shallow surficial deposits around the reservoir rim and on the reservoir slopes that are currently below the reservoir surface (Appendix B: *Definite Plan*). Small, shallow soil failures in the more deeply weathered volcaniclastic beds and in colluvial deposits present a minor hazard to Copco Road where the road is immediately adjacent to the shore (Appendix B: *Definite Plan*). These slope failures are likely to be shallow and local and therefore, if they were to occur, would constitute a less than significant impact.

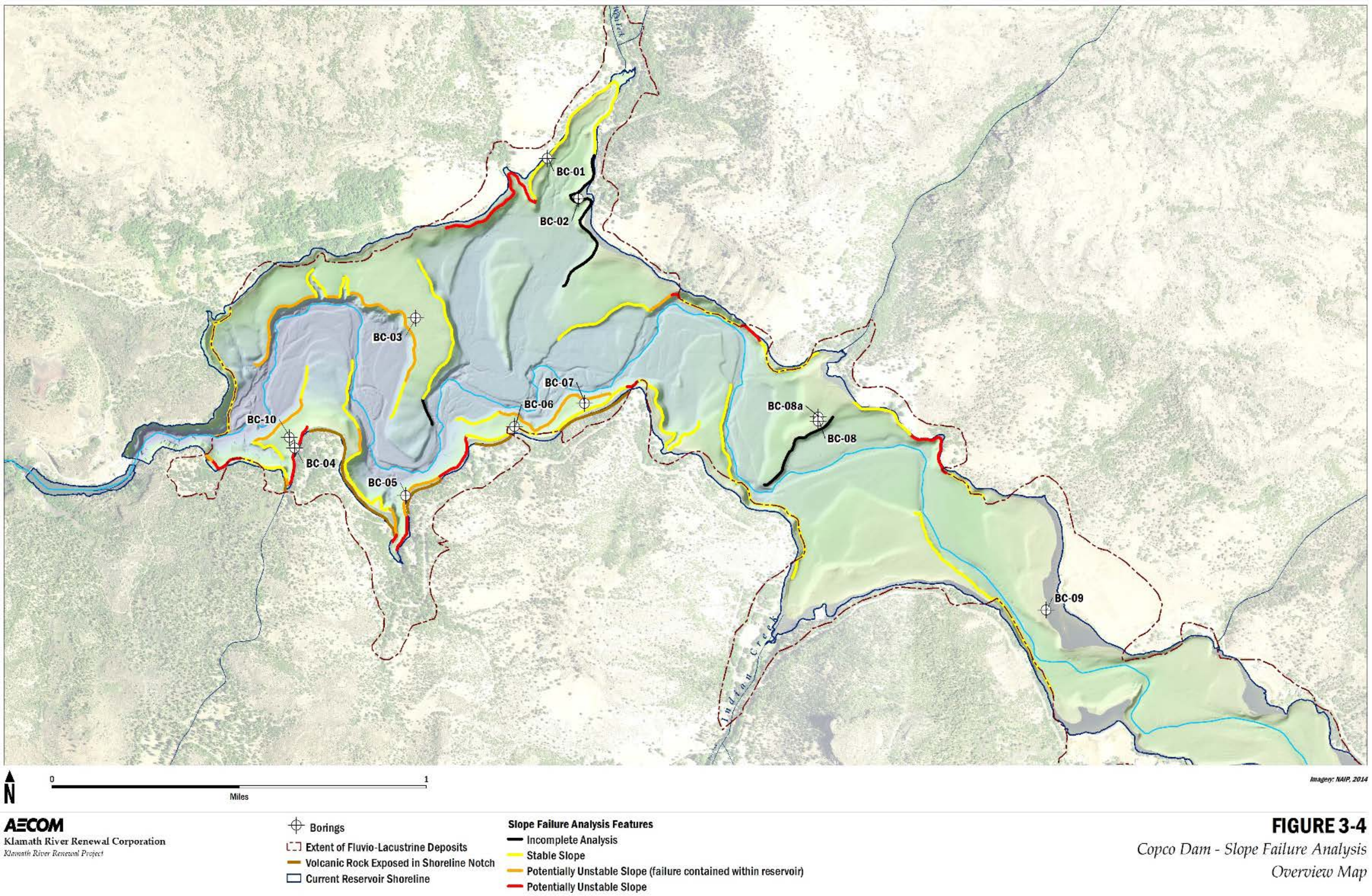

Figure 3.11-10. Results of slope failure analysis at Copco No. 1 Reservoir (Appendix B: *Definite Plan*).

Mitigation Measure GEO-1 – Slope Stabilization.
KRRC will visually monitor large, potentially unstable areas within the Copco No. 1 Reservoir footprint for the duration of reservoir drawdown and for two weeks following drawdown. Depending on the location, monitoring may involve tribal monitors (see also Mitigation Measures TCR-1, TCR-2, and TCR-3). If slope failure is observed, an exclusion zone will be established around the unstable area and the KRRC will monitor the unstable area.

Following drawdown activities, and once the areas are safe to inspect, the KRRC shall inspect any slope failures and implement slope stabilization measures, as appropriate. For any large slope failure that occurs during drawdown or the year following drawdown, KRRC will offset potential impacts by implementing the following actions:

1. Move affected structures or purchase affected property,
2. Re-align affected road segments,
3. Engineer structural slope improvements (e.g., drilled shafts or other structural elements that could be installed to resist slope movement), and
4. Revegetate affected areas.

Significance
No significant impact at Iron Gate Reservoir and J.C. Boyle Reservoir

No significant impact with mitigation for diatomaceous deposits along the rim and below the Copco No. 1 Reservoir water level

Potential Impact 3.11-4 Reservoir drawdown could result in short-term instability of embankments at the earthen dams (Iron Gate and J.C. Boyle).
Analyses of embankment stability during drawdown at the earthen dams (i.e., Iron Gate Dam and J.C. Boyle Dam) indicate factors of safety greater than the selected minimum factor of safety of 1.3. The analyses indicate that the proposed reservoir drawdown rates would not result in substantial embankment instability (Appendix B: *Definite Plan*). While there is a potential for small, shallow slumping along the upstream embankment slopes due to the potential strength loss of surficial materials during drawdown, this degree of slumping would not threaten the structural integrity of the embankments or deliver a substantial amount of sediment. The impact would be a less than significant in the short term (less than two years following dam removal). Copco No. 1 and No. 2 dams are concrete structures that would be unaffected by reservoir drawdown rate.

Significance
No significant impact

Potential Impact 3.11-5 Reservoir drawdown could result in substantial short-term sediment deposition in the Klamath River downstream of Iron Gate Dam due to erosion of reservoir sediment deposits and a long-term change in sediment supply and transport due to dam removal.
Based on average annual sediment deposition rates, approximately 15.1 million yd3 (4.16 million tons) of sediment would be deposited behind the dams by 2020 (USBR 2012) (Table 3.11-6). Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual

sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable to the Proposed Project.

Table 3.11-6. Estimated Amount of Sediment in the Lower Klamath Project Reservoirs in 2020 (Source: USBR 2012).

Reservoir	Estimated 2020 Total			
	Total Volume (yd^3)	Total Sediment (tons)[1]	Fine Sediment[2] (tons)	Sand[3] (tons)
J.C. Boyle	1,190,000	340,000	220,000	120,000
Copco No. 1	8,250,000	2,090,000	1,800,000	290,000
Iron Gate	5,690,000	1,730,000	1,460,000	280,000
Total[4]	**15,130,000**	**4,160,000**	**3,480,000**	**680,000**
Total Copco No. 1 and Iron Gate	**13,940,000**	**3,820,000**	**3,260,000**	**560,000**

[1] Ton is defined as equal to 2,000 pounds (dry weight).
[2] Fine sediment is sediment with a diameter less than 0.063 millimeters.
[3] Sand is sediment with a diameter between 0.063 and 2 millimeters.
[4] Sediment volumes and weights from individual reservoirs from USBR (2012) were rounded to the nearest 10,000th unit. Copco No. 2 Reservoir does not retain measurable amounts of sediment and therefore is not included in the estimates of total stored sediment.

Reservoir sediment consists primarily of silts and clays that would be easily eroded during drawdown. Approximately 36 to 57 percent of the total sediment stored in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs by 2021 would be eroded and transported downstream during the drawdown period and the year following dam removal (i.e., short-term), or an estimated 5.4 to 8.6 million yd^3 (1.2 to 2.3 million tons) (Table 3.11-7, Figure 3.11-11). Approximately 15 percent of this sediment eroded from reservoir areas during the first year following dam removal would be transported farther downstream as bedload.

The rate of reservoir drawdown would affect the amount of erosion of the sediment deposit. A faster drawdown rate would reduce the time of interaction between the flow and reservoir sediment deposits, thus reducing the overall amount of sediment erosion, whereas a slower drawdown rate would increase the time of interaction between the flow and reservoir sediment deposits, thus increasing the overall amount of sediment erosion. It is expected that increasing the previously modeled maximum drawdown rate of 2.25 to 3 feet per day (USBR 2012b) to the Proposed Project maximum drawdown rate of 5 feet per day (Appendix B: *Definite Plan – Appendix P*) would slightly decrease the total amount of sediment erosion that occurs during drawdown. The previously modeled maximum drawdown rate would result in erosion of 36 to 57 percent of the reservoir sediment deposits (Table 2.7-11). Increasing the drawdown rate to 5 feet per day would most likely result in less erosion than previously modeled.

Erosion and transport of sediment deposits within Copco No. 1 and Iron Gate reservoirs during drawdown would be assisted by using barge-mounted pressure sprayers to jet water onto newly exposed reservoir sediment deposits as the water level drops (a process referred to as sediment jetting). Sediment jetting would maximize erosion of reservoir sediment deposits in historical floodplain areas (especially the historical two-year floodplain) during drawdown and minimize the potential for future erosion of reservoir sediment deposits after the drawdown period. Additionally, removal of reservoir sediment deposits with sediment jetting would promote riparian bank and floodplain connectivity by increasing river inundation on the historical floodplain during high flow events and minimize manual excavation and grading of sediments from proposed restoration sites after completing drawdown. Sediment jetting would be focused in the six areas where restoration actions are proposed within the Copco No. 1 Reservoir footprint (Figure 2.7-9) and the three areas where restoration actions are proposed within the Iron Gate Reservoir footprint (Figure 2.7-10).

While the anticipated amount of sediment that will be eroded varies by reservoir, approximately 36 to 57 percent (5.4 to 8.6 million yd^3 [1.2 to 2.3 million tons]) of the total 2020 reservoir sediment volume is expected to erode and be transported downstream during the drawdown period (Table 2.7-1). Large quantities of sediment would remain in place after dam removal in each of the former reservoirs, primarily in areas above the active channel. The remaining sediments would consolidate (dry out and decrease in thickness). Studies of the existing sediments in J.C. Boyle Reservoir show an anticipated change in sediment depth of up to 61 percent of original depth (USBR 2012a). A higher degree of shrinkage of the sediment layers is expected in Copco No. 1 and Iron Gate reservoirs due to the increased organic matter content in these sediment deposits.

The range in the estimated volume of sediment eroded from each reservoir is primarily dependent upon whether the prevailing hydrology during reservoir drawdown corresponds to a dry hydrologic year or a wet hydrologic year. The majority of the erosion would occur during the reservoir drawdown process and would be a combination of direct erosion of sediment by moving water, slumping of the fine sediment along the reservoir sides toward the river, and sediment jetting of some areas of reservoir-deposited sediments during drawdown. In a dry hydrologic year, reservoir pool levels can be drawn down steadily and relatively quickly, resulting in a shorter period of interaction between the flow and sediment deposits, and thus less overall sediment erosion. In a wet hydrologic year, the reservoir pool may experience cycles of drawdown followed by periods of refilling during high flow events, resulting in longer period of interaction between the flow and the sediment deposits, and thus more overall sediment erosion.

Table 3.11-7. Estimated Amount of Sediment Erodible with Dam Removal (Source: USBR 2012).

Reservoir	Percent Erosion[1]		Fine Sediment Erosion		Sand Erosion	
	Minimum Erosion (percent)	Maximum Erosion (percent)	Minimum (tons)	Maximum (tons)	Minimum (tons)	Maximum (tons)
J.C. Boyle	27	51	60,000	110,000	30,000	60,000
Copco No. 1	45	76	820,000	1,370,000	130,000	220,000
Iron Gate	24	32	350,000	460,000	70,000	90,000
Total	36	57	1,230,000	1,950,000	230,000	370,000
Total Copco No. 1 and Iron Gate	36	56	1,170,000	1,830,000	200,000	300,000

1 The erosion rates are based on hydrologic conditions recorded for the March to June flow volume at Keno gage on the Klamath River from water year 2001(90 percent exceedance) and 1984 (10 percent exceedance). Erosion would primarily occur during the drawdown period. Additional erosion and sediment transport could occur in the following year that would be indistinguishable from the background sediment regime.

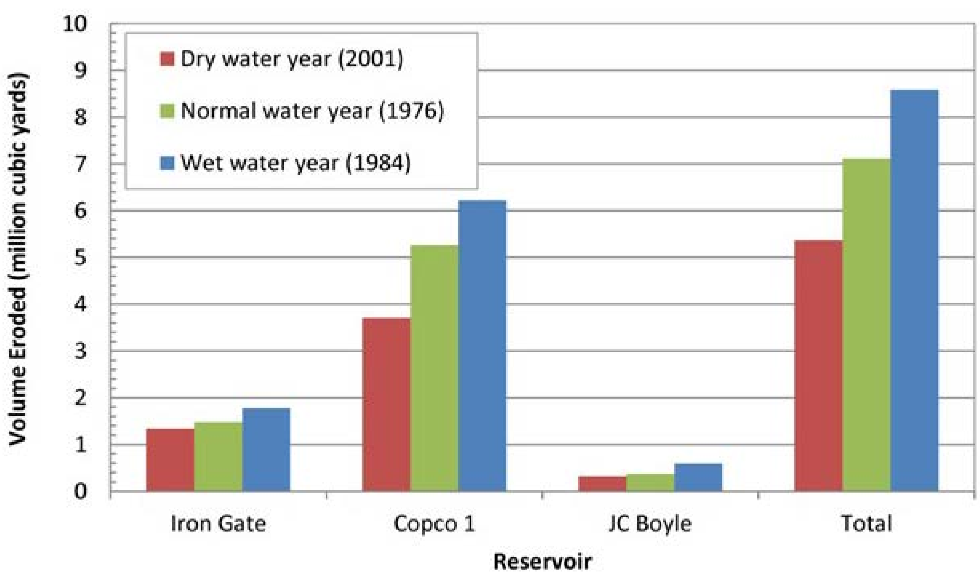

Figure 3.11-11. Volume of Sediment Eroded from Reservoirs in the Hydroelectric Reach During 2020 Drawdown Beginning in January (USBR 2012).

Model simulations indicate that 43 percent to 64 percent of the sediment stored in the reservoirs would remain in place following the year after dam removal (i.e., long-term), primarily as a relatively thin wedge in areas above the active channel. The remaining sediment would consolidate (i.e., harden, dry, shrink in volume, and decrease in thickness) following reservoir drawdown (USBR 2012). Studies of the existing sediment in Lower Klamath Project reservoirs indicate an anticipated change in sediment thickness in J.C. Boyle Reservoir of up to 61 percent due to consolidation (USBR 2012). A higher degree of shrinkage of the sediment layers is expected for Copco No. 1 and Iron Gate reservoirs due to the increased organic matter content in the sediment deposits contained within these reservoirs. Sediment deposits remaining in the reservoir footprints following reservoir drawdown would erode slowly, or potentially not at all due to consolidation. Secondary erosion of residual reservoir deposits would be affected by increases in shear strength with desiccation, the prevalence of cracks, and disintegration in response to wetting and drying cycles. The prevalence of cracking would encourage gully erosion as lower infiltration rates intensify surface runoff and concentrate flow in cracks. Gullies would incise and widen with time. The availability of coarse sediment (i.e., sand and larger) to abrade fine-grained deposits may be an important factor encouraging gully erosion. Gullies closer to coarse sediment sources (e.g., near the steep hillslopes at Copco No. 1 and Iron Gate reservoirs) may have more effective secondary erosion than areas lacking those sediment sources (e.g., Upstream Reach of J.C. Boyle Reservoir) (Appendix B: *Definite Plan*). As riverine conditions return within the reservoir footprints, any additional erosion and transport of reservoir sediment farther downstream would be indistinguishable from background rates within the watershed. Overall, this degree of long-term erosion would be a less than significant impact. Future construction activities (e.g., access road construction, recreation facilities) would need to consider the potential instability and erodibility of sediment remaining within the reservoir footprints.

Anticipated erosion volume due to dam removal into the context of annual basin-wide sediment discharge are estimated to average an annual total sediment supply from the Klamath River to the Pacific Ocean of approximately 5.8 million tons (4 million tons/yr of fine sediment and 1.8 million tons/yr of sand and larger sediment (Stillwater Sciences (2010). Farnsworth and Warrick (2007) estimate that the average annual silt and clay discharge is 1.2 million tons/yr. The considerable uncertainty in the annual average sediment load estimates is related to the different approaches to estimation, the large variation in the measurement of SSCs, the lack of a unique relationship between flow and SSC, and the large annual variation in sediment loads. In dry years the supply of sediment to the ocean could be less than 1 million tons/yr (Figure 3.11-12). Given these estimates, it is expected that the amount of sediment released during the year of drawdown and dam removal would be similar to that transported by the Klamath River to the Pacific Ocean in a year with average flow, much less than that transported by the Klamath River in a wet year, and greater than that transported by the Klamath River in a dry year.

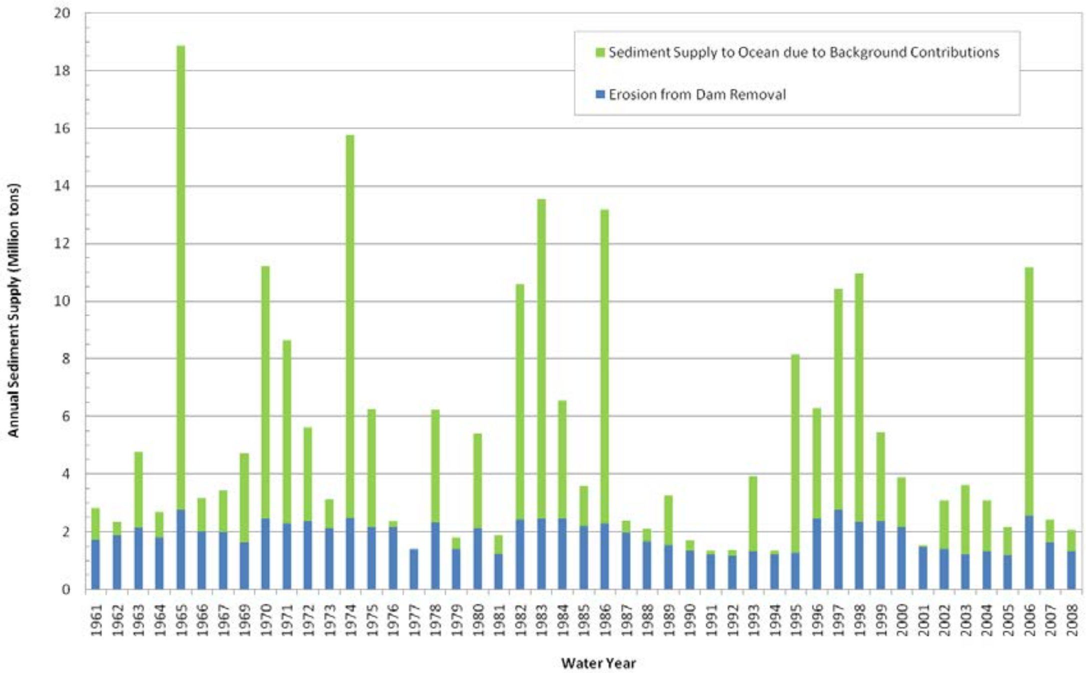

Figure 3.11-12. Annual predicted sediment delivery to the Pacific Ocean under the Proposed Project and existing conditions ("Background Contributions") by water year. Model results are only valid for the year of dam removal, and no significant increase in sediment loads is predicted in years following dam removal (Source: USBR 2012).

Channel Response in the Hydroelectric Reach

SRH-1D modeling results indicate channel bed elevations would decrease and median channel substrate size would increase within the reservoir reaches during drawdown (January to May of the drawdown year) (Figure 3.11-13, Figure 3.11-14). The proportion of fine sediment would decrease to near zero within two months after drawdown; the proportion of sand would initially increase to 30 to 50 percent then decrease to 10 to 25 percent; the proportion of gravel would change (mostly increase) to 20 to 35 percent; and the proportion of cobble would increase to 50 to 70 percent. The estimated changes depend on the reservoir and simulation water year type (i.e., wet, median, or dry). These changes would stabilize within six months as the bed within the historical river channel reaches pre-dam elevations (USBR 2012). After dam removal, channels currently inundated by reservoirs would likely vary from narrow, single-threaded to wide and sinuous with the potential to form complex features, such as meander cut-offs and vegetated islands (USBR 2012).

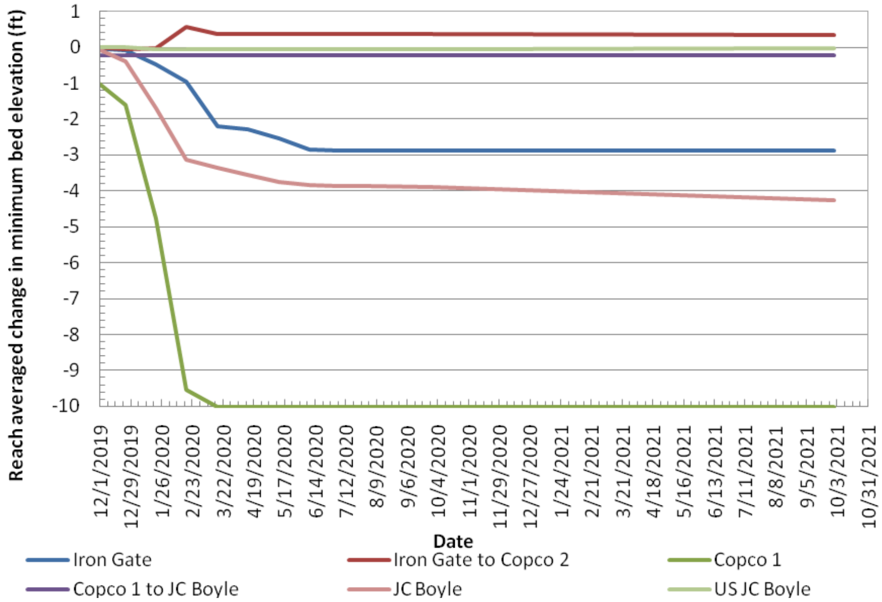

Figure 3.11-13. Reach-Averaged Erosion in the Hydroelectric Reach during a Representative Wet Water Year (USBR 2012).

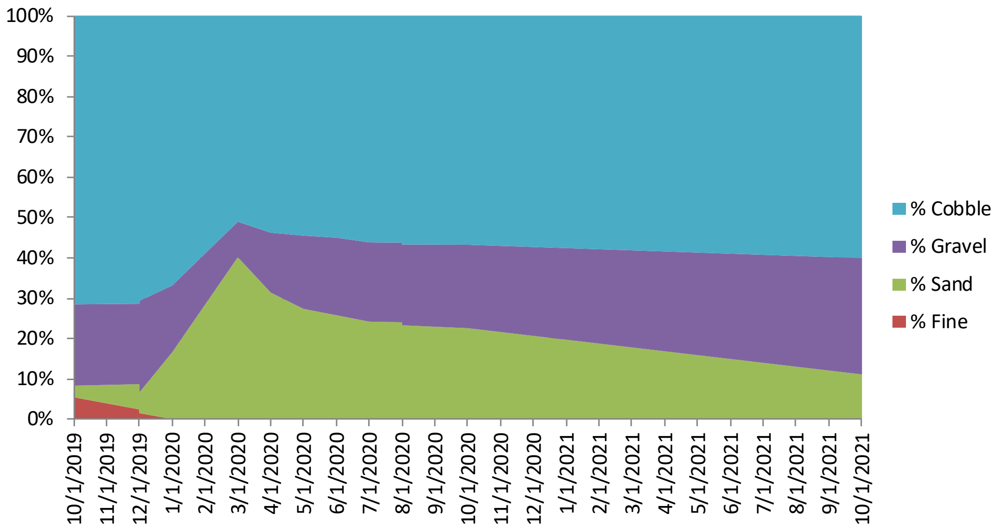

Figure 3.11-14. Simulated Bed Composition from Copco No. 2 to Iron Gate Reservoirs during Two Successive Representative Dry Water Years During and After Drawdown (Based on simulation results provided by USBR, March 2012).

The river reaches upstream of J.C. Boyle Reservoir and from Copco No. 1 Reservoir to J.C. Boyle Dam would experience little change in bed composition or median substrate size during drawdown (USBR 2012). Currently, these reaches are predominantly cobble (90 percent) with small fractions of gravel and sand. Modeling of the Copco No. 2 Dam to Iron Gate Reservoir reach shows decreases in the combined proportion of sand and fines, with the dry simulations showing decreases to approximately 35 percent of sand and fines two years after drawdown.

Channel Response in the Klamath River Downstream of Iron Gate Dam

The short-term (i.e., two years following dam removal) effects of the Proposed Project on dam-released sediment and sediment resupply would likely extend from Iron Gate Dam to approximately Cottonwood Creek (USBR 2012). Because approximately 85 percent of the sediment stored within the reservoirs is fine (silt and clay), most sediment eroded from the reservoirs would be fine. Fine sediment transport rates would increase downstream of Iron Gate Dam during the short-term, but a large portion of this fine sediment would be transported to the ocean as suspended sediment shortly after being eroded (Stillwater Sciences 2010, USBR 2012). Coarse sediment (i.e., sand and larger) transport would occur more slowly depending on the frequency and magnitude of mobilization flows and attenuation by channel storage.

Short-term (2-year) SRH-1D model simulations indicate up to about 0.9 feet of reach-averaged deposition between Bogus Creek and Willow Creek (RM 188.0), and up to about 0.4 feet of deposition from Willow Creek to Cottonwood Creek (USBR 2012) (Figure 3.11-15). Model simulations indicate that reaches located farther downstream will change little (< 0.5 ft). Eight miles of the Klamath River mainstem channel could potentially be affected by sediment release and resupply, representing 4 percent of the total mainstem channel length downstream of Iron Gate Dam (190 miles).

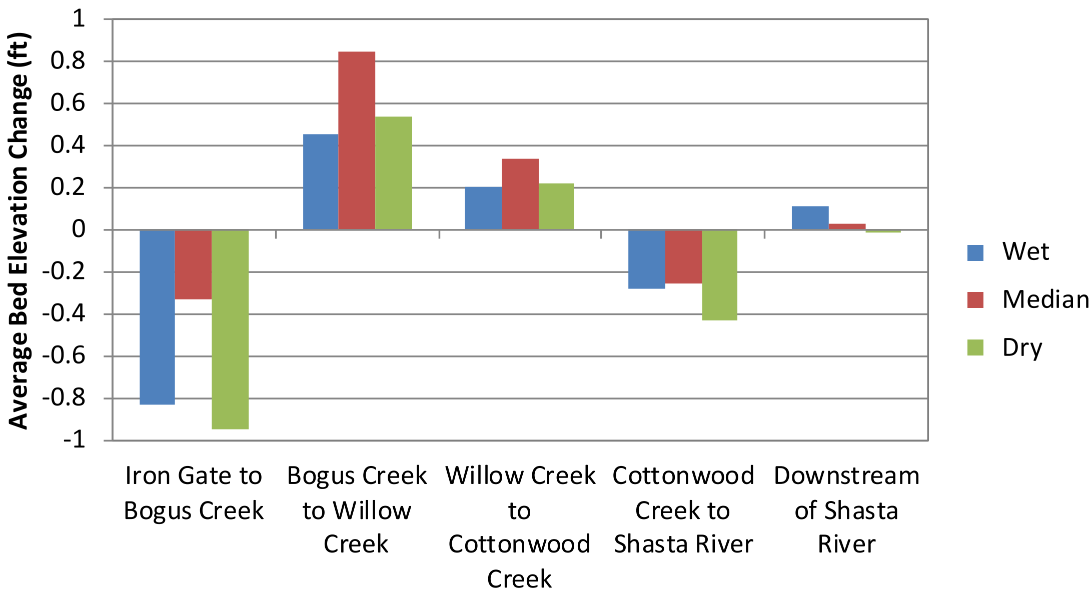

Figure 3.11-15. Reach Averaged Bed Elevation Change for Two Successive Wet, Median, or Dry Water Years Following Reservoir Drawdown (Based on simulation results provided by USBR, March 2012).

It is not possible to accurately predict short-term deposition patterns in the mainstem river channel at a fine spatial scale (e.g., individual pools or other slack-water areas) under the Proposed Project using 1D sediment transport models. However, the general short-term sediment transport and depositional patterns can be reasonably surmised based on patterns observed in the Klamath River and other analogous river channels. Dam-released sediment may temporarily deposit in pools and other slack water areas (e.g., eddies) and at tributary confluences in the reach from Iron Gate Dam to Cottonwood Creek. These transient sediment deposits would be highly erodible during subsequent flow events, leading to a short residence time (i.e., likely one year or less except during dry years). KRRC proposes a channel survey to document pool depths in the Klamath River from Iron Gate Dam to Humbug Creek prior to dam removal, and every year after dam removal for the first 3 years

In the short term, SRH-1D model simulations indicate that dam-released sediment and sediment resupply under the Proposed Project would increase the proportion of sand in the channel bed and decrease median bed substrate size (Figure 3.11-16 and Figure 3.11-17) (USBR 2012). Under wet, median and dry simulations, sand within the bed in the reach from Iron Gate to Bogus Creek would increase to 30 to 35 percent by March to June of the drawdown year, gradually decreasing to 10 to 20 percent by September two years later. Median substrate size (D_{50}) would fluctuate slightly before stabilizing to approximately existing conditions with a D_{50} of 100 mm (Appendix F). Short-term model simulations also indicate a decrease in median grain size (from an initial value of approximately 80 mm down to 40 to 65 mm) and an increase in the proportion of sand (up to 40 percent) in the reach from Bogus Creek to Willow Creek, and an increase in the proportion of sand (up to 35 percent) and a decrease in median grain size (from an initial value of approximately 65 mm down to 38 to 45 mm) in the reach from Willow Creek to Cottonwood Creek (Appendix F).

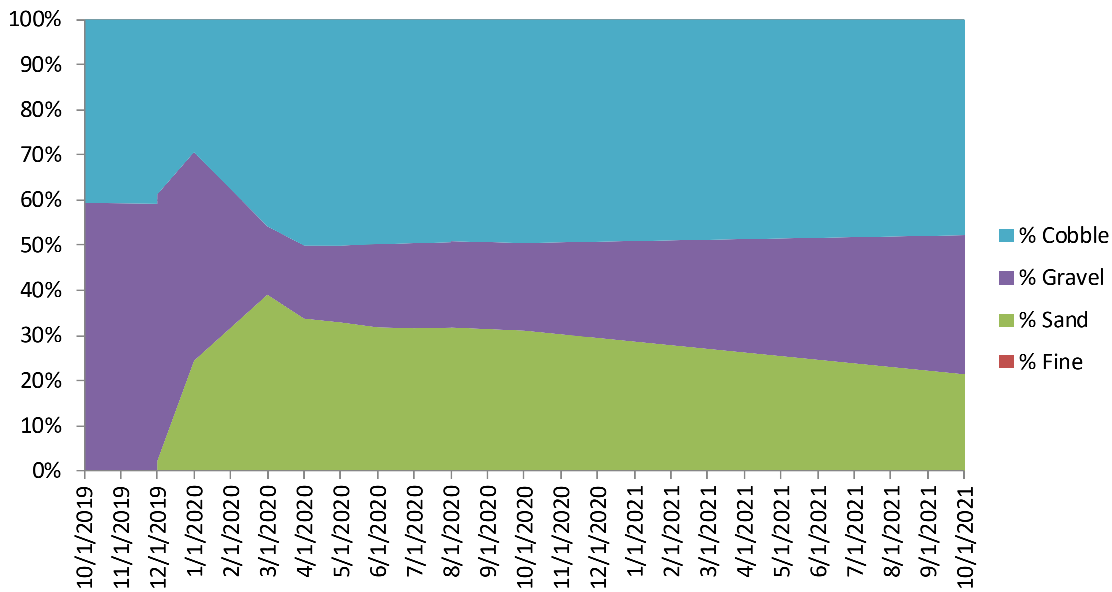

Figure 3.11-16. Simulated Bed Composition from Iron Gate Dam to Bogus Creek during Two Successive Dry Water Years Following Reservoir Drawdown (Based on simulation results provided by USBR, March 2012).

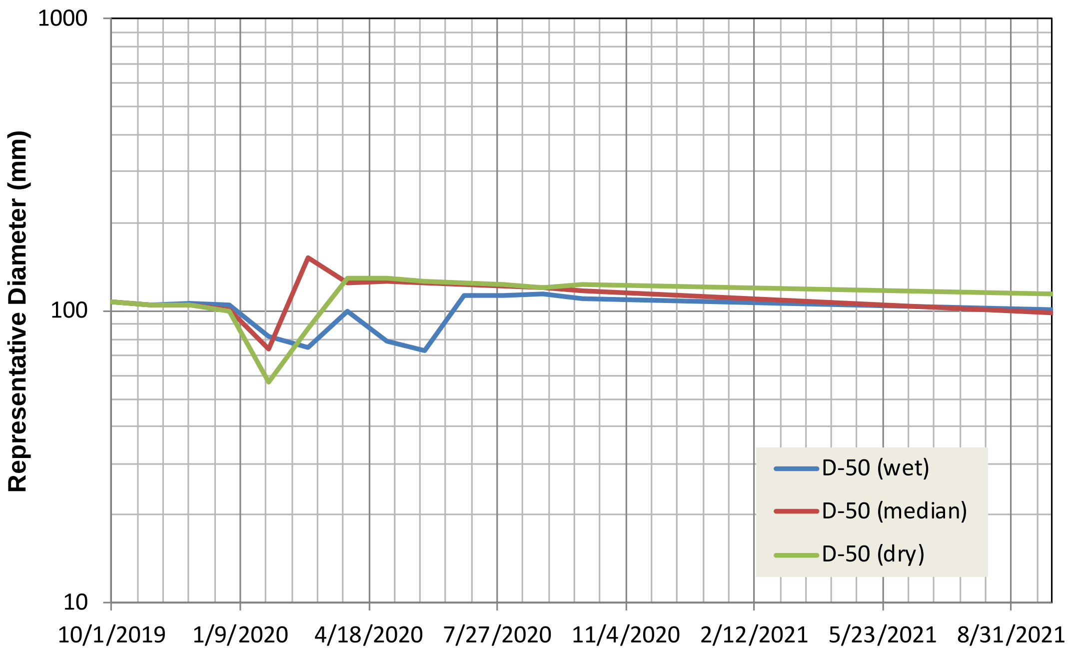

Figure 3.11-17. Simulated D50 (mm) from Iron Gate Dam to Bogus Creek during Successive Wet, Median, and Dry Water Years Following Reservoir Drawdown (Based on simulation results provided by USBR, March 2012).

In general, the Proposed Project would have the beneficial long-term (i.e., 50 years) effects of increasing sediment supply and transport and creating a more dynamic and mobile bed downstream of Iron Gate Dam. During the 50 years following the initial release of sediment by the Proposed Project, bed elevations would adjust to a new equilibrium in response to sediment supplied by upstream tributaries within the Hydroelectric Reach. While 0.8 to 1.7 feet of aggradation could result from the Proposed Project between Iron Gate Dam and Cottonwood Creek (i.e., simulations based on a median start year), no long-term sediment deposition is expected downstream of Cottonwood Creek (USBR 2012). Long-term (5 to 50 year) simulations indicate that after 5 years, the Proposed Project would increase the proportion of sand in the bed to 5 to 22 percent and decrease the D_{50} to approximately 50 to 55 mm (Appendix F). These changes would stabilize and continue through to Year 50. Fining of the bed surface would reduce the flow required to mobilize the channel bed from approximately 10,000 cfs to 6,000 cfs in the reach from Bogus Creek to Willow Creek (RM 192.6 to RM 188) and from 11,000 cfs to 6,000 cfs in the reach from Willow Creek to Cottonwood Creek (RM 188 to RM 185.1) (USBR 2012). The corresponding return period for a bed-mobilizing flow in the reach from Iron Gate Dam to Cottonwood Creek (USGS RM 193.1 to RM 185.1) would decrease from 4 years to approximately 2 years.

Channel Response in the Klamath River Estuary

The majority of the fine sediment (silts, clays, and organics) released by dam removal would be transported to the ocean. The fine material is unlikely to deposit in significant quantities in the estuary, evidenced by the lack of a large sandbar within the mouth of the Klamath River under existing conditions. There are currently high concentrations of silt and clay transported through the estuary, and sediment sampling by USBR (2010) documented the absence of fine material in the estuary except in the backwater and vegetated areas. If dam removal occurs during a low flow year, there may be relatively small volumes of sediment deposited in these areas.

Pacific Ocean Nearshore Environment

Because of the complexities of the transport processes, the area and depth of fine sediment deposition in the Pacific Ocean nearshore environment resulting from the Proposed Project cannot be precisely predicted. A considerable amount of fine sediment is anticipated to initially deposit on the seafloor shoreward of the 196-feet isobath along the coast, with greater quantities depositing in close proximity to the mouth of the Klamath River. After fine sediment loading onto the continental shelf during river floods, fluid-mud gravity flows typically transport fine sediment offshore. Summer coastal upwelling naturally re-suspends some of the river sediments that are transported to the nearshore environment and deposited on the continental shelf, especially those from the previous winter (Ryan et al. 2005; Chase et al. 2007; see Potential Impact 3.2-7). Along with the background river sediments transported annually by the Klamath River and deposited on the continental shelf, a portion of the sediment deposited on the continental shelf following dam removal would also have the potential to be re-suspended during the summer coastal upwelling. Any sedimentation of the nearshore seafloor resulting from the Proposed Project would likely be transported farther offshore to the mid-shelf and into deeper water depths off-shelf. The short-term (less than two years following dam removal) and long-term (2–50 years following dam removal) effects of the Proposed Project on sediment delivery to the Pacific Ocean would be less-than-significant, given the relatively small amount of total sediment input from reservoir sediment release in comparison to the total annual naturally occurring sediment inputs to the nearshore environment.

Bedload sediment effects related to coarse sediment released by the Proposed Project or sediment re-supply likely would not extend downstream of the Cottonwood Creek confluence (RM 185.1). Therefore, there would be no bedload-related effects in the Klamath River Estuary or Pacific Ocean nearshore environment under the Proposed Project.

Significance

Significant and unavoidable in Middle Klamath River from Iron Gate Dam to Cottonwood Creek in the short term

No significant impact in the Middle Klamath River downstream of Cottonwood Creek, Lower Klamath River, and Klamath River Estuary in the short term

Beneficial for Hydroelectric Reach, Middle and Lower Klamath River, and Klamath River Estuary in the long term

No significant impact in Pacific Ocean nearshore environment in the short term and long term.

Potential Impact 3.11-6 Reservoir drawdown could result in increased bank erosion in the Klamath River downstream of Iron Gate Dam.

Reservoir drawdown could increase bank erosion in downstream reaches if, as a result of the Proposed Project, river discharge increases such that higher stages exert more force on erodible banks over a longer period of time. Under the Proposed Project, drawdown of the four reservoirs would occur simultaneously beginning in January of the drawdown year (Copco No. 1 Reservoir would also experience early drawdown starting November of the year prior to drawdown, at a lower rate [maximum of 2 feet per day]), see also Section 2.7.2 *Reservoir Drawdown*). Section 3.6 *Flood Hydrology* discusses historical flow rates and discharge statistics for each of the reservoirs. The proposed drawdown rates are consistent with the historical discharge rates from the reservoirs and would be adjusted depending on the water year; therefore, flow rates downstream of the dams are not anticipated to increase substantially above median historical rates, if at all (discharges from the reservoirs would be similar to, or less than, seasonal 10-year flood flows from the reservoirs).

Although some erodible banks have been identified in the Lower Klamath River, based on expected drawdown flow rates which are similar to existing flow rates, substantial amounts of additional bank erosion are not expected to occur downstream of any of the dams during reservoir drawdown. Therefore, bank erosion in downstream reaches due to reservoir drawdown would be a less than significant impact.

Significance
No significant impact

Potential Impact 3.11-7 Reservoir removal could reduce or eliminate the availability of a known mineral resource or a locally-important mineral resource recovery site.
Diatomite deposits near the southern downstream shore of Copco No. 1 Reservoir are currently inaccessible for extraction purposes due to their location in the reservoir and existing erosion. Under the Proposed Project, land ownership within the reservoir areas would be transferred to the KRRC and then to California, or to a designated third-party transferee, in the case of Copco No. 1 Reservoir (Section 2.7.10 *Land Disposition and Transfer*). The lands would thereafter be managed for public interest purposes, which could include open space, active wetland and riverine restoration, river-based recreation, grazing, and potentially others. While it is possible that the diatomite deposits would become more available than under the existing condition, it is also possible that they would continue to be inaccessible in the short and long term. Thus, this EIR does not consider the accessibility of diatomite deposits to be a beneficial effect, but rather a continuation of the existing condition.

Significance
No significant impact

3.11.6 References

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3.12 Historical Resources and Tribal Cultural Resources

This section focuses on the potential for impacts to historical and tribal cultural resources due to the Proposed Project. For the purposes of this section of the EIR:

Tribal Cultural Resources: Tribal Cultural Resources (TCRs) are defined consistent with Public Resources Code section 21074(1)(a) which includes sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a California Native American tribe that are either included or determined to be eligible for inclusion in the California Register of Historical Resources, or included in a local register or historical resources, or as determined by the lead agency under the criteria for listing (PRC 210749(1)(a)).

Historical Resources: Historical Resources are defined consistent with Public Resources Code section 21084.1 which includes a resource listed in, or determined to be eligible for listing in, the California Register of Historical Resources, or as determined by the lead agency (PRC 21084.1).

Many comments were received during the NOP public scoping process relating to historical and/or tribal cultural resources (Appendix A). Several commenters expressed a profound personal and tribal connection to the Klamath River, its water quality, and its fishery from a traditional, subsistence, ceremonial, and spiritual viewpoint, and expressed that dam removal would provide an opportunity for river restoration, including the return of a traditional fishery. Other commenters expressed concern regarding low flows and poor water quality that would ensue following dam removal and could preclude certain tribal ceremonies. Several commenters expressed concern regarding dam removal and the potential for impacts to specific known cultural resources associated with ancient Shasta tribal occupation of the landscape and that there may be unknown archaeological resources that could be adversely affected by dam removal. A summary of the historical and/or tribal cultural resources comments received during the NOP public scoping process, as well as the individual comments themselves, are presented in Appendix A.

Assembly Bill 52 (AB52) (Gatto 2014) amended Section 5097.94 of the Public Resources Code to require consideration of tribal cultural resources in CEQA review, and to require certain consultation requirements with California Native American Tribes. AB 52's requirements went into effect on July 1, 2015.

A tribal cultural resource is defined as a site, feature, cultural landscape, sacred place or object with cultural value to a California Native American tribe that is listed or determined to be eligible for listing in the California Register of Historical Resources or under certain local registers, or that the lead agency determines to be significant under the criterial for listing. (Public Resources Code, Section 21074, subdivision (a).).

The Yurok Tribe, the Shasta Indian Nation and the Shasta Nation requested consultation under AB 52, and met with the State Water Board and the KRRC in a series of confidential consultation meetings within the timeframe of February 2017 through October 2018. The consultations with the Yurok Tribe and the Shasta Indian Nation resulted in identification of potentially-impacted resources, articulation of potential impacts, and development of, and agreement on, specific mitigation measures (see Section 3.12.5.1 *Potential Impacts to Tribal Cultural Resources*, TCR-1 through TCR-8).

KRRC has formally committed to implementing the measures as part of concluding AB 52 consultation, and has initiated consultation for development of a Tribal Cultural Resources Management Plan to meet the requirements described in TCR-1 through TCR-4, as well as the requirements of National Historic Preservation Act, Section 106. The TCRMP will be submitted to FERC for implementation.

Consultation with the Shasta Nation has informed the analysis in this EIR, but concluded after the Shasta Nation and the State Water Board acknowledged that it would not be possible to reach agreement on mitigation measures, despite a good faith effort to do so.

In order to support Project development, the KRRC undertook efforts to identify and evaluate historical and tribal cultural resources in the vicinity of the Proposed Project, and these efforts have provided information contributing to the Historical and Tribal Cultural Resources environmental setting, potential impacts and mitigation measures. KRRC has also prepared a Draft Cultural Resources Plan (Appendix B: *Definite Plan – Appendix L*), which provides a framework for understanding the cultural resources studies that KRRC has completed, those that are currently ongoing, and others that KRRC anticipates completing in order to comply with regulatory requirements. The KRRC proposes that the Final Cultural Resources Plan would be available prior to implementation of the Proposed Project.

3.12.1 Area of Analysis

The Area of Analysis for historical and tribal cultural resources is shown in Figure 3.12-1. Within the Area of Analysis, there are four subareas relevant to the analysis of potential historical and tribal cultural resource impacts, as follows:

- *Subarea 1* (Figure 3.12-2)
  - KRRC's Limits of Work for the Proposed Project, which includes the horizontal boundary conforming to the high-water line around the Lower Klamath Project reservoirs, the construction footprint needed for dam and other structure removal, ingress and egress routes, staging and stockpiling areas, disposal areas, and transmissions lines to be removed; and,
  - The inclusive area of known cultural sites that lie partially within and partially outside of the Limits of Work.
- *Subarea 2* (Figure 3.12-3)
  - Post-dam removal altered Federal Emergency Management Agency (FEMA) 100-year floodplain along the 18-river mile stretch of the Middle Klamath River downstream of Iron Gate Dam (RM 193.1) to the confluence with Humbug Creek (RM 174).
- *Subarea 3* (Figure 3.12-4)
  - 0.5-mile buffer on either side of the Hydroelectric Reach, Middle Klamath River, and Lower Klamath River encompassing the existing conditions and post-dam removal altered FEMA 100-year floodplain, which, with the exception of the Middle Klamath River reach described in *Subarea 2*, have the same extent.
- *Subarea 4* (Figure 3.12-5)
  - Parcel B lands immediately surrounding the Lower Klamath Project, which would be transferred from PacifiCorp to the KRRC prior to dam removal and

then transferred to the respective states (i.e., California, Oregon), as applicable, or to a designated third-party transferee, following dam removal. The lands would thereafter be managed for public interest purposes (KHSA Section 7.6.4.A).

To allow for individual impact analyses specific to geographic location (e.g., reservoir footprint, riverside location) and Proposed Project activity timing (e.g., pre-dam removal, reservoir drawdown, restoration activities), the subareas include overlap. The subarea overlap has no bearing on the analysis of any impact, since the subareas are considered independently by impact.

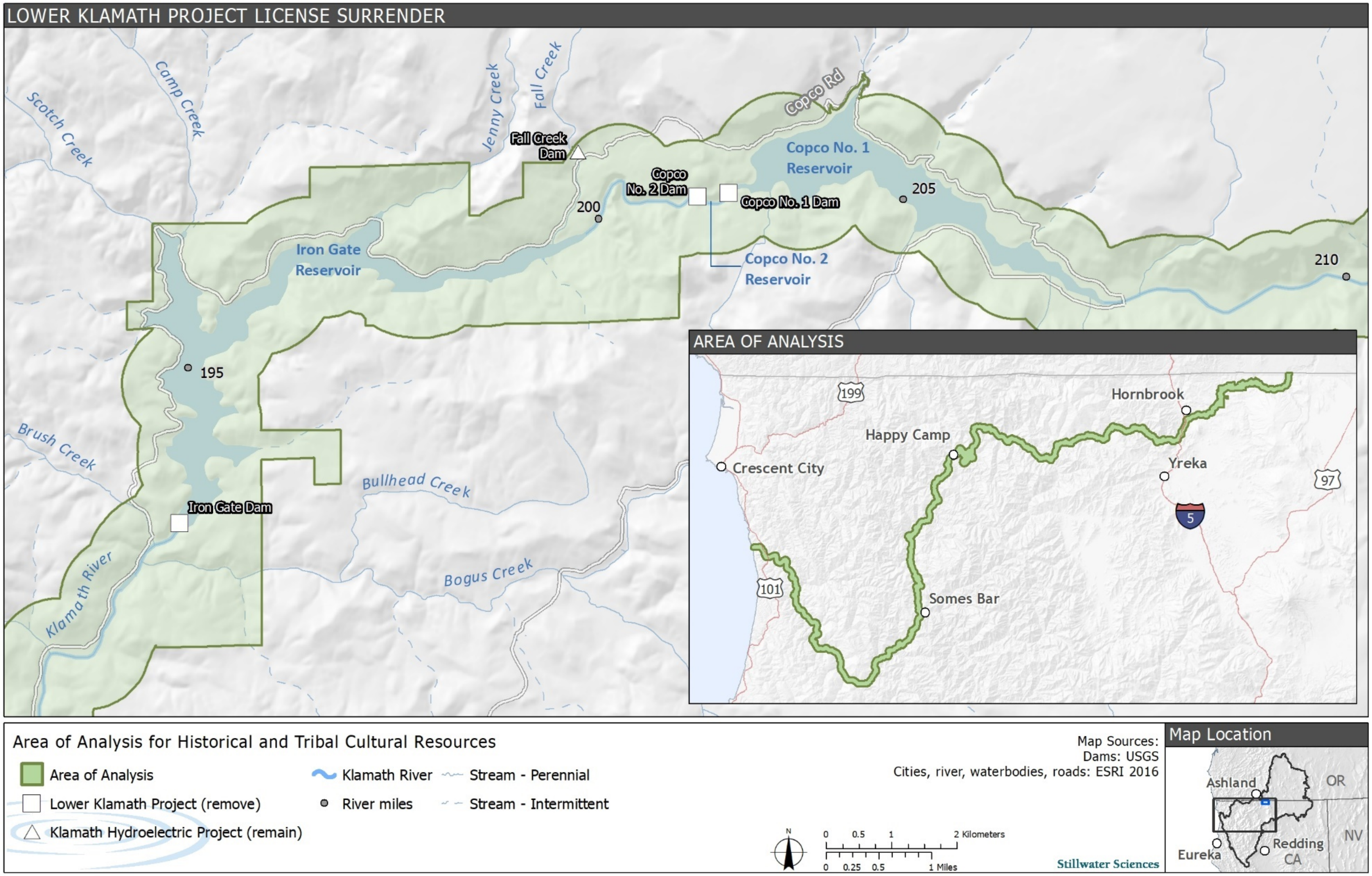

Figure 3.12-1. Area of Analysis for Historical and Tribal Cultural Resources.

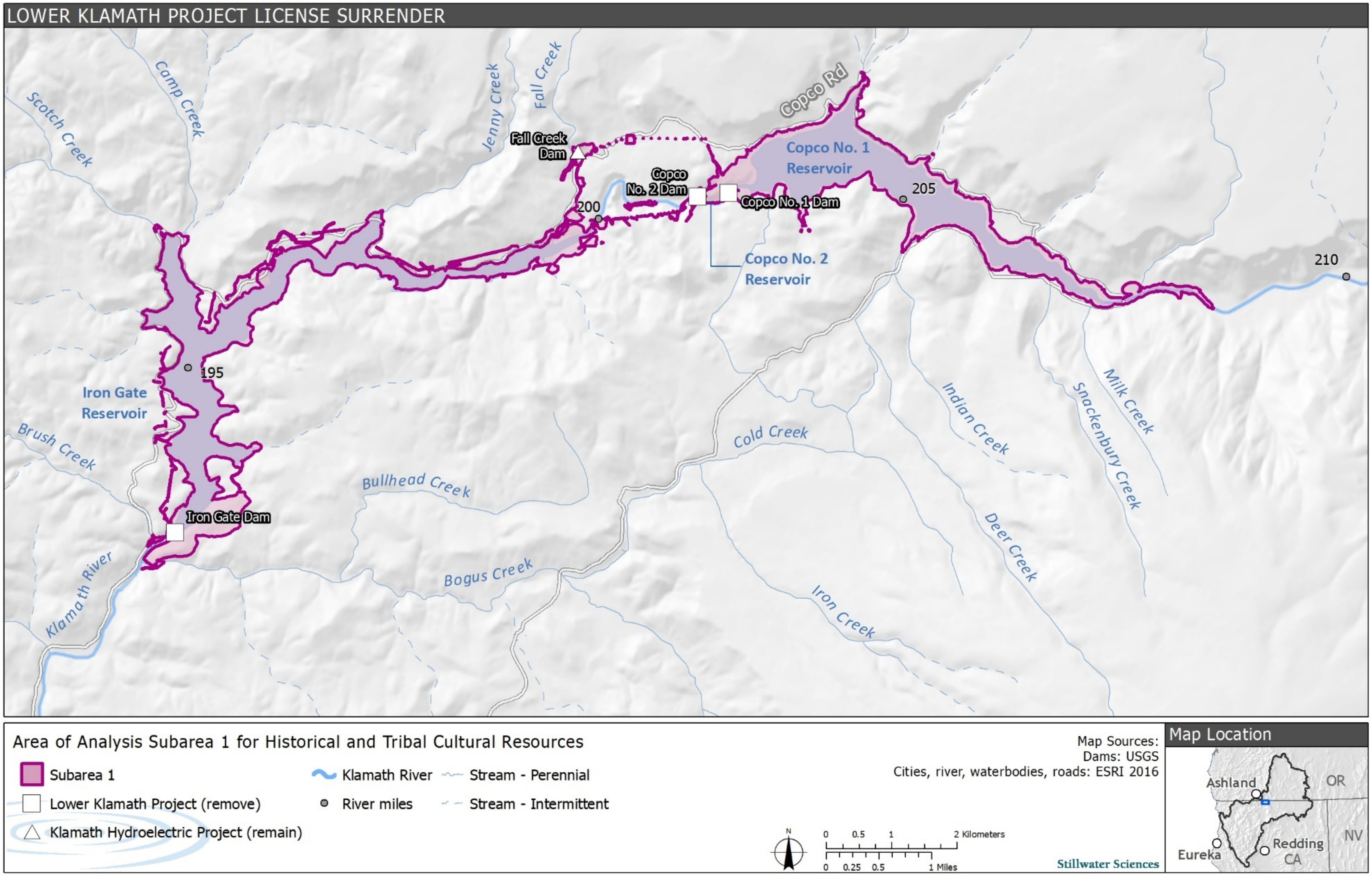

Figure 3.12-2. Area of Analysis *Subarea 1* for Historical and Tribal Cultural Resources.

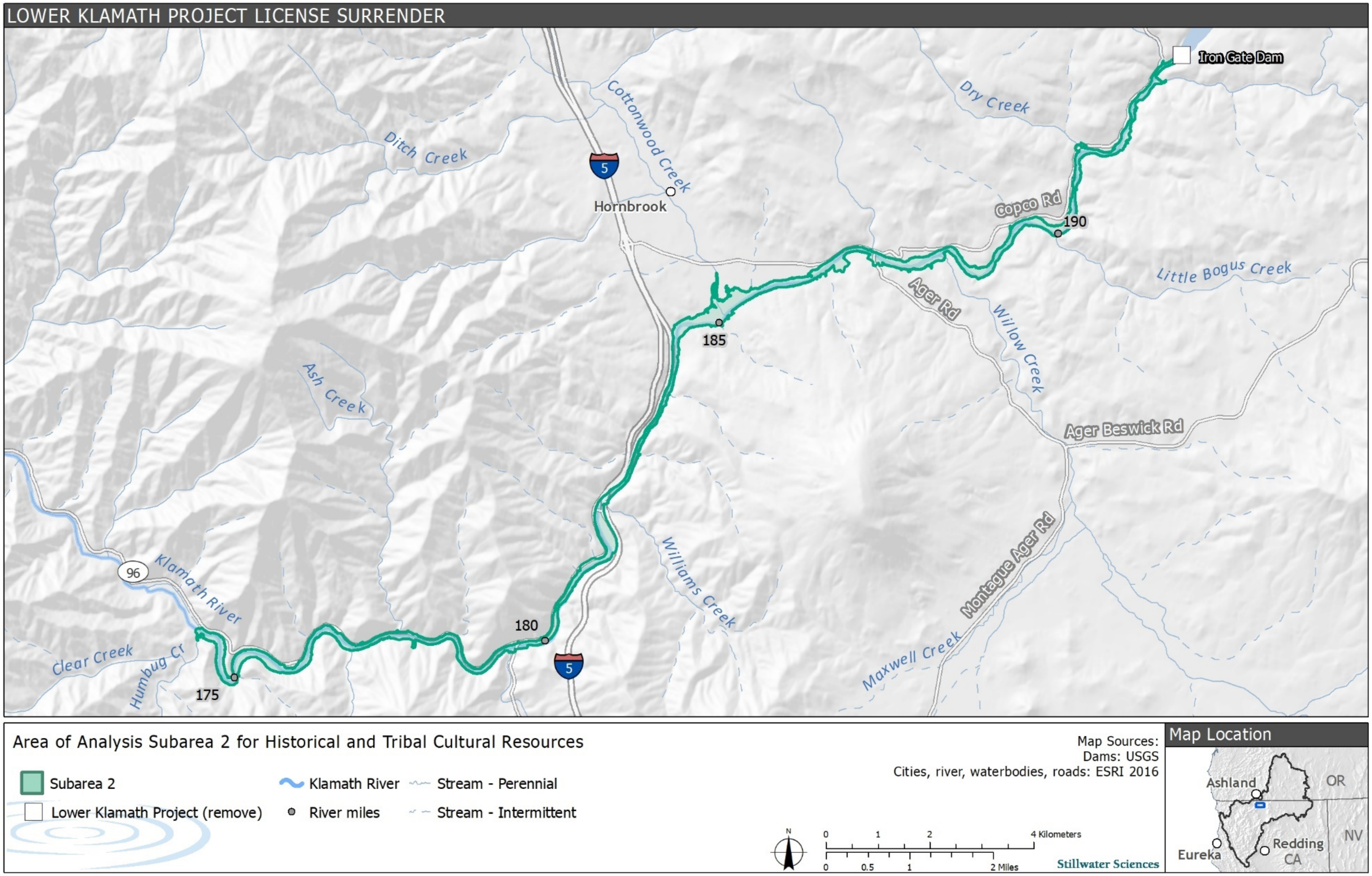

Figure 3.12-3. Area of Analysis *Subarea 2* for Historical and Tribal Cultural Resources.

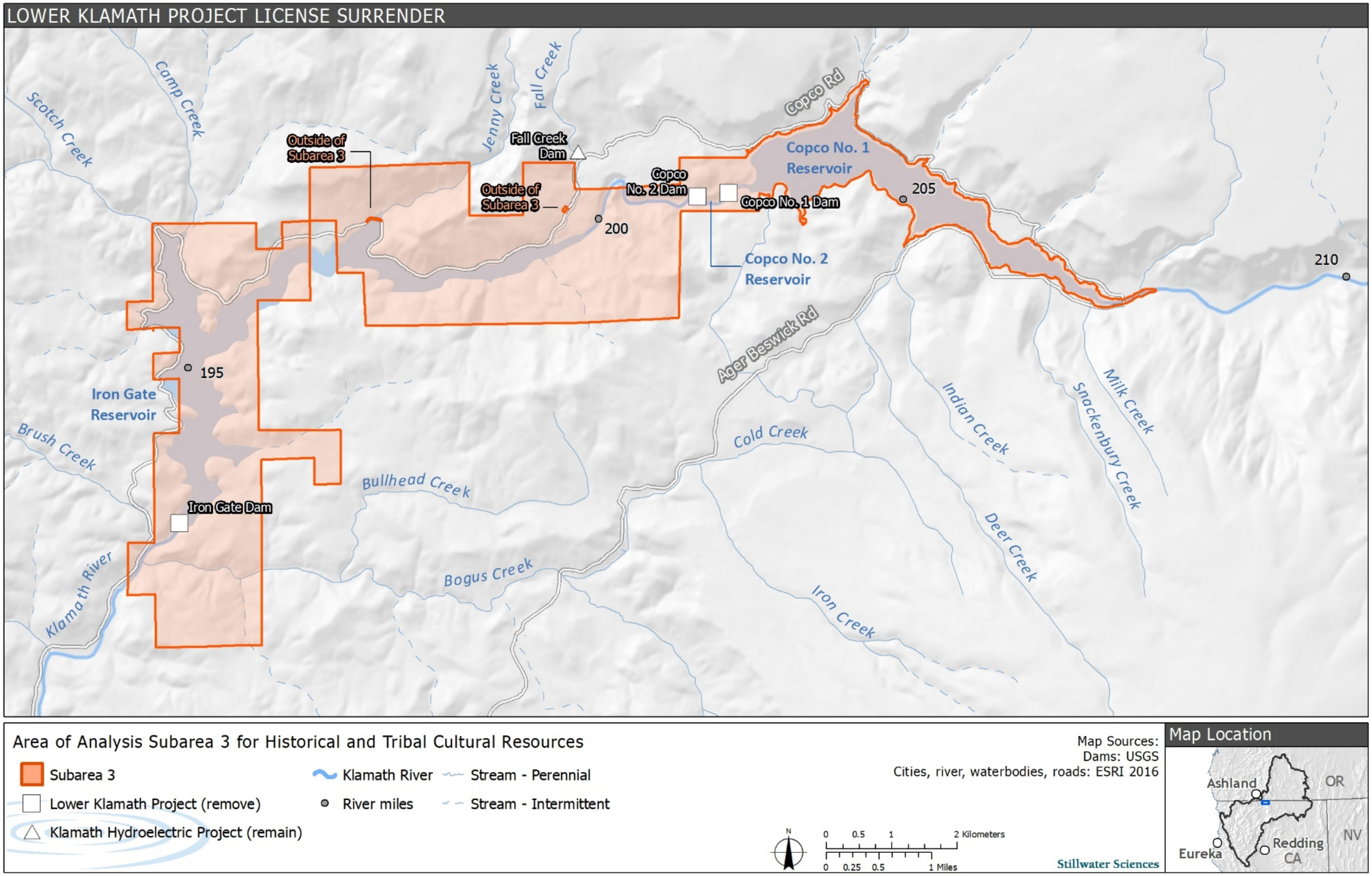

Figure 3.12-4. Area of Analysis *Subarea 3* for Historical and Tribal Cultural Resources.

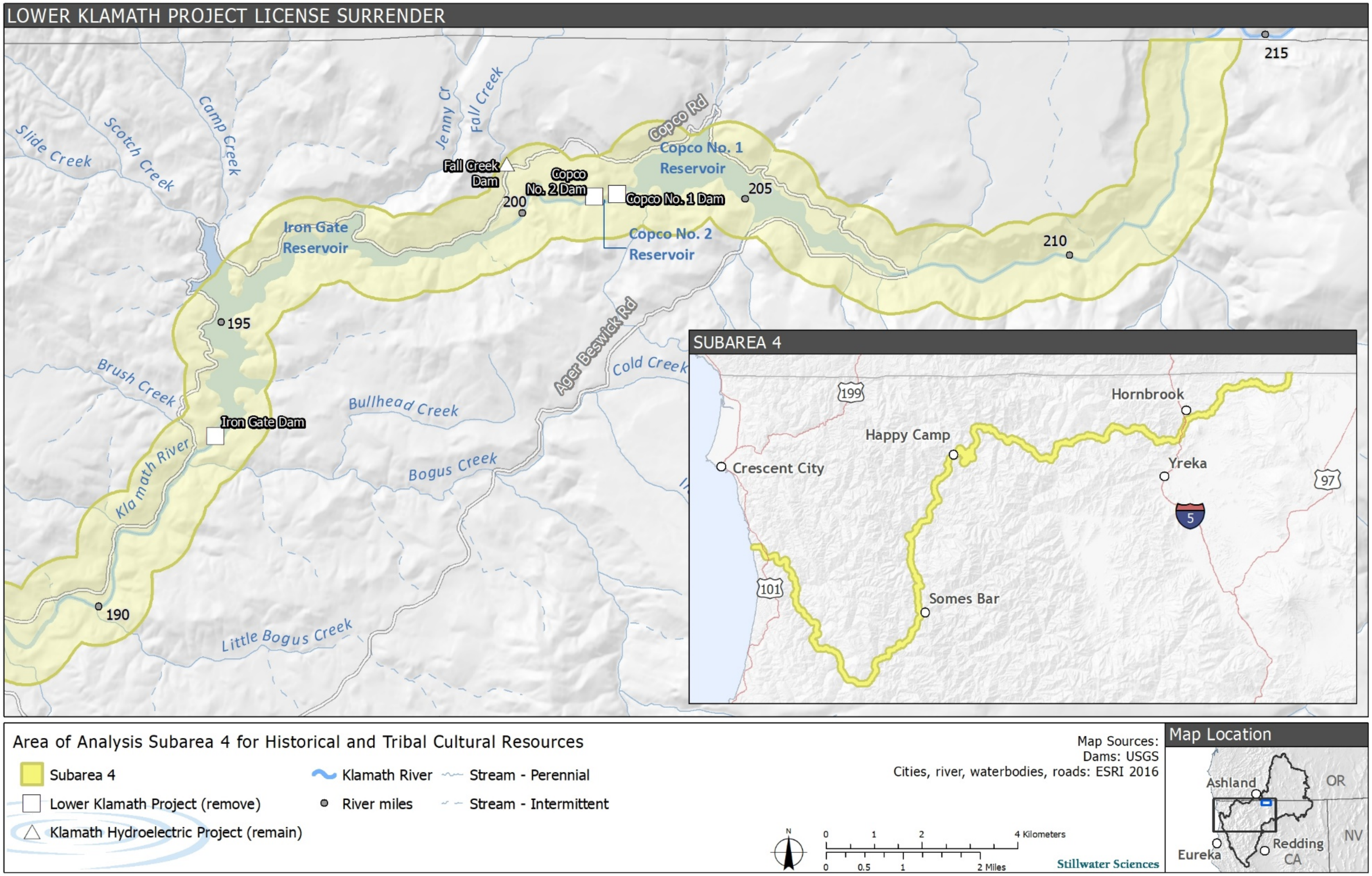

Figure 3.12-5. Area of Analysis *Subarea 4* for Historical and Tribal Cultural Resources.

3.12.2 Environmental Setting

The Klamath River flows through several cultural regions in California's Northwest Coast, the Great Basin, and portions of the Columbia Plateau. These unique cultural regions have been used and occupied by Native American peoples for centuries.

3.12.2.1 Tribal Cultural Chronology and Ethnography (including Historic and Pre-Historic Periods)

The tribal cultural resources analysis focuses on Shasta, Klamath, Karuk, Modoc, Hupa[177], and Yurok peoples that occupy the territory along and adjacent to the Klamath River in the vicinity of the Proposed Project. These tribes have a long history of occupation along the Klamath River as evidenced by the numerous archaeological and ethnographical resources that are present. Traditional beliefs indicate that these groups have occupied the area for time immemorial.

Over the millennia, native peoples occupied the area along the Klamath River in the vicinity of the Proposed Project, especially the corridor along the Klamath River. Ancient stream terraces—composed of gravel and sand and covered in meadows of grass with mixed oak groves—provided ideal conditions for food supply. Additionally, the area of the Upper and Middle Klamath River provided naturally occurring salt deposits, geothermal hot springs, basalt rock caves, and food such as anadromous and resident fish, seeds, roots, birds, and mammals.

Archaeological investigations have confirmed over 10,000 years of human presence in the Middle and Upper Klamath Basins, which extend beyond the extent of the Klamath River (Balter 2008, Ames et. al 1998, and Aikens and Jenkins 1994). Mammal remains document their use as a food source for native people approximately 7,500 years before the present (BP) (Ames et al., 1998). The presence of milling slabs, mortars, and mullers on the landscape dating back to approximately 6,000 BP, provides evidence for use of bulbs and seeds for subsistence (Mack 1983 and 1991). Use of fish, as a food source, began about 2,600 years BP (Beckham 2006, Daniels 2006, Deur 2011).

Section 3.12 *Tribal Trust* of the 2012 KHSA EIS/EIR is included as Appendix V of this EIR, and includes significant additional context regarding the histories of Native Americans in the basin and the longstanding relationships with various resources. Because this information was developed under auspices of the USBR's trust responsibilities towards federally-recognized Native American tribes, it includes only federally-recognized tribes. Additionally, the subsections of Section 3.12 *Tribal Trust* that address the various potential impacts of the alternatives that were being evaluated in the 2012 KHSA EIS/EIR are not directly applicable to the Proposed Project because they involve similar, but not exactly the same, actions.

Columbia Plateau and Great Basin Culture Areas

The Upper Klamath Basin and Klamath Lakes area exhibits a blend of cultural traits from the Columbia Plateau and Great Basin culture areas. The chronology of the area may be organized into the Paleoarchaic (14,000 to 7,000 BP), Early Archaic (7,000 to 4,500 BP), Middle Archaic (4,500 to 2,500 BP), and Late Archaic/Late Prehistoric (2,500 to 200 BP) periods (Ames et al. 1998; Balter 2008; Aikens and Jenkins 1994; Mack 1983, 1991).

Paleoarchaic (14,000 to 7,000 BP)
During the Paleoarchaic period, the Klamath Basin was occupied by hunter-gatherers that tended to focus on hunting large game animals, but also supplemented their diet with fish, birds, and plant resources. These groups were seasonally mobile and generally small in size (Ames et al. 1998). Two of the oldest sites in the region are Paisley Cave, which is dated at 14,200 BP (Balter 2008) and Fort Rock Cave, which is dated between 13,200 and 10,200 BP (Aikens and Jenkins 1994). The oldest site in the upper Klamath River area is the Klamath Shoal midden site, 35KL21, which yielded a date of 7,700 BP.

Early Archaic (7,000 to 4,500 BP)
Most of the archaeological evidence for early human occupation in the Klamath River Canyon dates to the beginning of the Early Archaic period (Mack 1983 and 1991). Semi-subterranean house pits first appear in the Plateau region during this period suggesting that some people were adopting a less mobile lifestyle. Typical artifacts associated with the Early Archaic include large stemmed, lanceolate, or leaf-shaped projectile points, knives, gravers, scrapers, and some cobble and ground stone tools (e.g., abraders or grinding slabs, mortars, mullers, and stone bowls).

Middle Archaic (4,500 to 2,500 BP)
The Middle Archaic period is characterized by an increase in the exploitation of riverine and marsh environments and food resources such as salmon and various plant roots/tubers. There was also an increase in the use of milling stones and pestles at sites during this period. Typical Middle Archaic artifacts include broad-necked, corner-notched, and side-notched projectile points, many types of ground stone tools, bone and antler tools (e.g., chisels and wedges), and specialized fishing gear (e.g., bone harpoon barbs and net sinkers).

Late Archaic/Late Prehistoric (2,500 to 200 BP)
Several major cultural changes occurred during the Late Period, including: the widespread appearance of pit houses; a shift to a heavy reliance on fishing; the use of storage pits for salmon; camas exploitation; the development of seasonal land use patterns (i.e., use of “winter villages”); the appearance of the bow as evidenced by the presence of small corner- and side-notched projectile points at sites; and the appearance of Olivella shell beads. Extensive trade networks became important across the region by as early as 1,500 years ago, as suggested by tools made from obsidian sources 110 to 120 miles away and the presence of beads made from marine shells.

<u>Ethnography</u>
Klamath Tribes: The Klamath Tribes include the Klamath, Modoc, and Yahooskin Band of Snake Indians. Prior to their placement on a shared reservation, these groups utilized overlapping resource areas in the Upper Klamath Basin. The Klamath and Modoc people occupy the entire Upper Klamath Basin and adjacent interior drainages to the east, living in close association with the marsh and riverine resources of this area (Spier 1930 and Barrett 1910). The Klamath and Modoc tribes were occupying the Upper Klamath Basin prior to Euro-American contact, and also participated in salmon fishing and social gatherings along the Klamath River at least as far downstream as Seiad Valley (Deur 2011). The Yahooskin principally occupy lands east of the Klamath Basin, but did participate in resource harvests, including fish harvests, with Klamath and Modoc on the Sprague River and other Klamath River tributaries (Deur 2011).

Deur (2011) also presents a summary of the ethnography of The Klamath Tribes and their relationship to the Klamath River. Klamath ancestral territory stretches from the southern boundary of the Deschutes River watershed in the north to Shovel Creek drainage in the south (Stern 1998). These encompass the Sprague River and Sycan Rivers, Sycan Marsh, Klamath Lake, and Klamath Marsh (Spier 1930, Berreman 1937). Modoc territory extends from Mount Shasta in the south to an area near the current Oregon-California state line in the north and from the eastern slope of the Cascade Range near Mount Shasta to the area around Goose Lake in the east (Ray 1963). This area encompassed Lower Klamath Lake and Tule Lake.

Klamath and Modoc were both organized in villages that collectively owned productive fishing or other resource (e.g., seed or other plants) gathering areas. Influential heads of households, supported by extended families, assumed leadership roles in the villages (Stern 1998). Villages included various types of structures including semi-subterranean winter lodges for families and extended families. The Klamath and Modoc rebuilt their winter lodges in the fall. Spier (1930) identified five geographic subdivisions of winter villages:

- Klamath Marsh-Williamson River group on the southern margin of Klamath Marsh and the Lower Williamson and Sprague rivers (about 34 villages, plus four to five villages on the upper Sprague and Sycan rivers).
- Agency Lake group on Agency Lake and the northern arm of Klamath Lake (one village and one hamlet).
- Lower Williamson River group close to the mouth of Williamson River (about seven villages).
- Pelican Bay group that includes the Pelican Bay district on the west side of Klamath Lake, Four Mile Creek, and the marsh north of the lake (about eight villages).
- Klamath Falls group: along Klamath Lake south of Modoc Point (about 14 villages).

The permanent winter villages were never fully abandoned during the year. Each group of villages maintained one or more places for cremation of the dead. The ashes of cremated individuals were covered with soil and rocks. Individuals dying away from home might be interred under piles of rocks or cremated and returned to the cremation ground. Particular sweat houses, said to have been built by the legendary *Kemu'kumps*, and a hot spring were used to cleanse mourners.

Fish is the primary resource for the Klamath and Modoc; consequently, settlements clustered near rivers and streams. Runs of fish began in the early spring and lasted into the fall (Spier 1930). Men, with some assistance from women, fished throughout the year from the banks of rivers or streams or from canoes using long-handled dip nets, spears, harpoons, and hook-and-line. During parts of the year, fish drives were also used to harvest fish. Members of the tribe would drive fish toward individuals dragging triangular nets on A-frames or purse nets through the water either on foot or from a canoe. Gill nets drawn between canoes and traps were also used to acquire fish. In addition, stone barriers were constructed on some streams to restrict fish passage and facilitate fishing.

Klamath and Modoc typically left their winter villages in early spring to begin a seasonal round of harvest activities. Spring activities began with harvesting fish from the run of large suckers that took place in Upper Klamath Lake in March. Fish were dried on the branches of pine saplings and sometimes pounded into a meal and bagged for storage. As the spring sucker run subsided, Klamath and Modoc women turned their attention to digging ipos (*Carum oregonum*) roots, gathering waterfowl eggs, and scraping the cambium layers of young ponderosa pines for food. By late spring, women dug camas bulbs in wet meadows, baking them in earth ovens and sun-drying them for storage while men hunted waterfowl and other animals.

Summer was the season when women harvested wocas, the nutritious seeds of the yellow pond lily, at Klamath Marsh, Sycan Marsh, Tule Lake, Lower Klamath Lake, and other water bodies. Wocas were an important food resource and shaman conducted a ceremony at the beginning of the harvest. The seeds were processed for soup and flour. Women also collected cattail roots for drying and grinding into meal. During the summer months men hunted waterfowl and a variety of small mammals.

In fall, Klamath and Modoc gathered chokecherries, serviceberries, Klamath plums, pine nuts, blackberries, and gooseberries. Klamath and Modoc eventually moved into the high country of the western Cascades to harvest huckleberries. Women dried the berries before fires, while men hunted deer and elk and trapped furbearing mammals. Deer hunting methods included stalking and driving the animals into the lakes, rivers, or confined spaces where they could be clubbed by women in canoes or shot with bows and arrows. Whitefish were also harvested in the fall primarily by the use of dip-nets.

Klamath and Modoc sought power by visiting places where they believed that sacred beings resided and sought to gain their power through ritualized activities. Klamath and Modoc parents sent boys and girls on a power quest when they reached puberty. Fathers and mourning kinsmen sometimes sought power at the birth of a child or death of a wife or child (Stern 1998). Seekers of power often sought specific competence such as luck in hunting or fishing, war, love-making, gambling, foot-racing, or curing. Seekers of power went alone into the mountains for 5 days to fast, pile rocks, wrestle with trees, run, perhaps take sweat baths, and climb hills. Power might come in the form of a dream or a visit by a spirit, which would be followed by the seeker waking with blood in his mouth or nose and a personalized spirit song in his ears.

Shamans, mourners, and gamblers also sought power by swimming in deep river eddies. During the day, the seeker sweated and fasted, waiting in the brush until nightfall. At that time the power seeker went to the river and dove to the bottom in search of a spirit. The seeker did not appear to be frightened even if he saw something moving under the water. Similar to other power-seeking events, it is reported that sometimes a seeker surfaced from the bottom of the river unconscious, with blood flowing from his mouth and/or nose (Spier 1930).

Shamans performed important ceremonies in midwinter gatherings, first-fruit rites for wocas gathering, and other occasions. They also cured illnesses and provided spiritual and practical support during warfare. Novice shamans received their initiation as a group at midwinter ceremonies. Helpers worked with shamans over a 5-day period during the ceremonies to call spirits, interpret spirit messages, and lead the audience in singing sacred songs.

Euro American expansion into Klamath and Modoc territory had a dramatic effect on their traditional cultural practices. Regardless, The Klamath Tribes exhibited considerable and well-documented persistence in their ceremonial and social traditions, particularly as they related to site-specific and resource-specific traditions. However, in 1954 Congress terminated the reservation and its trust relationship with The Klamath Tribes. The Klamath Tribes retained some rights to resources, but a majority of the tribal members withdrew from the tribe and received a portion of the tribal holdings. The trust account created for the rest of the members was later liquidated. In addition, in 1974 the Federal Government condemned thousands of forest acres that had been part of the Klamath Reservation so that the forest land could be added to the Winema National Forest (Klamath Tribes 2003).

The Klamath Tribes accomplished restoration of Federal recognition in 1986 and began to rebuild their tribal government, economy, and community. Currently, the tribal Culture and Heritage Department is working to protect, preserve, and enhance traditional cultural values (Klamath Tribes 2003). The Klamath Tribes are also pursuing a variety of economic enterprises through their Economic Self-Sufficiency Plan. (Please refer to 2012 KHSA EIS/EIR Section 3.12 *Tribal Trust* in Appendix V of this EIR for additional information on traditional and current lifeways and the history of Federal recognition.)

Northern Interior California Culture Area

Previous archaeological investigations in the vicinity of the Proposed Project were conducted in response to hydroelectric developments and highway construction projects beginning in the 1940s. These early archaeological investigations contain limited general information on the cultural chronology of lands in the vicinity of the Proposed Project. However, the investigations of Basgall and Hildebrandt (1989) and Cleland (1997a,b) in the northern Sacramento River Canyon do offer information on cultural chronology of lands in the Sacramento River Canyon which can provide additional insights to cultural chronology of lands in the Proposed Project area because it is likely that the subsistence and settlement patterns identify for the Sacramento River Canyon are similar to the patterns along the Klamath River and within the vicinity of the Proposed Project.

Basgall and Hildebrandt (1989) propose a three-phase cultural chronology for the northern Sacramento River Canyon, which is thought to be similar to the prehistory of the Klamath Basin. These are the Pollard Flat Phase (2,700–5,300 BP), the Vollmers Phase (1,700–4,500 BP), and the Mosquito Creek Phase (1,900 BP to contact). The Pollard Flat Phase appears to represent a forager population that occupied residential base camps for extended periods of time, and is characterized by relatively large projectile points, ground stone tools, anvils, mauls, and net weights. The Vollmers Phase represents populations that were more mobile than those of the previous phase, while still maintaining residential camps, and are characterized by medium size projectile points, ground stone tools, anvils, mauls, and net weights. The Mosquito Creek Phase populations consisted of small groups that practiced a pattern of seasonal migration, and have ben archaeologically characterized by small projectile points, ground stone tools, and the absence of hand stones, milling stones, hammer stones, anvils, mauls, and net weights.

Cleland's (1997a,b) chronology for the Lake Britton area is divided into six periods spanning 7,000 years. The six periods include: Paleo-Indian (prior to 7,500 BP; Early Archaic-A (5,000–7,500 BP); Early Archaic-B (3,900–5,000 BP); Middle Archaic-A

(3,000–3,900 BP); Middle Archaic-B (2,000–3,000 BP); Late Archaic (1,000–2,000 BP); and Emergent (150–1,000 BP).

The Paleo-Indian Period is poorly represented at the Area of Analysis and only sporadic use of the area may have been occurring during this time. Early Archaic Period sites along the Pit River and Klamath River, however may be associated with an intensification of use of the area. Sites associated with this period are usually on mid-slope terraces and tend to be situated some distance from rivers. This period reflects increased occupation of the area and freshwater mussel shell midden deposits appear at sites suggesting the exploitation of riverine resources.

The Middle Archaic Period is highlighted by a continued increase in the intensity of use of the area and a diversification of the overall settlement pattern. Occupation of the higher terraces above the river continues, but habitation sites also occur closer to the river. The diversified settlement pattern of the Middle Archaic-A Period continues during the Middle Archaic-B Period, but there is increased occupation of sites near the river. The Late Archaic-A Period is characterized by an increase of more riverine sites. This pattern continues into the Emergent-A Period during which occupation of riverine sites intensifies.

Ethnography

Shasta People

The Shasta People are currently represented by various Native American entities including the Shasta Nation, Shasta Indian Nation, and the Etna Band of Indians otherwise known as the Ruffey Rancheria. During separate consultations between the State Water Board and the Shasta Indian Nation and Shasta Nation, tribal representatives provided various historic accounts related to locations, individuals, and significant events permanent to the specific tribe’s history and culture. These accounts, and specific tribal histories are included in confidential appendixes of this EIR (Confidential Appendix P and Q). Below is the traditional information provided for the Shasta people based on literary research.

Silver (1978) summarizes ethnographic information regarding Shasta collected by Dixon (1907), Voegelin (1942), and Holt (1946). These sources generally agree that traditional Shasta territory extended north to a point about 20 miles north of Ashland, Oregon, and from Clear Creek on the Klamath River east to Mt. Hebron (Silver 1978, Jester 2016) (Figure 3.12-6). Shasta are members of the Hokan language family (Silver 1978).

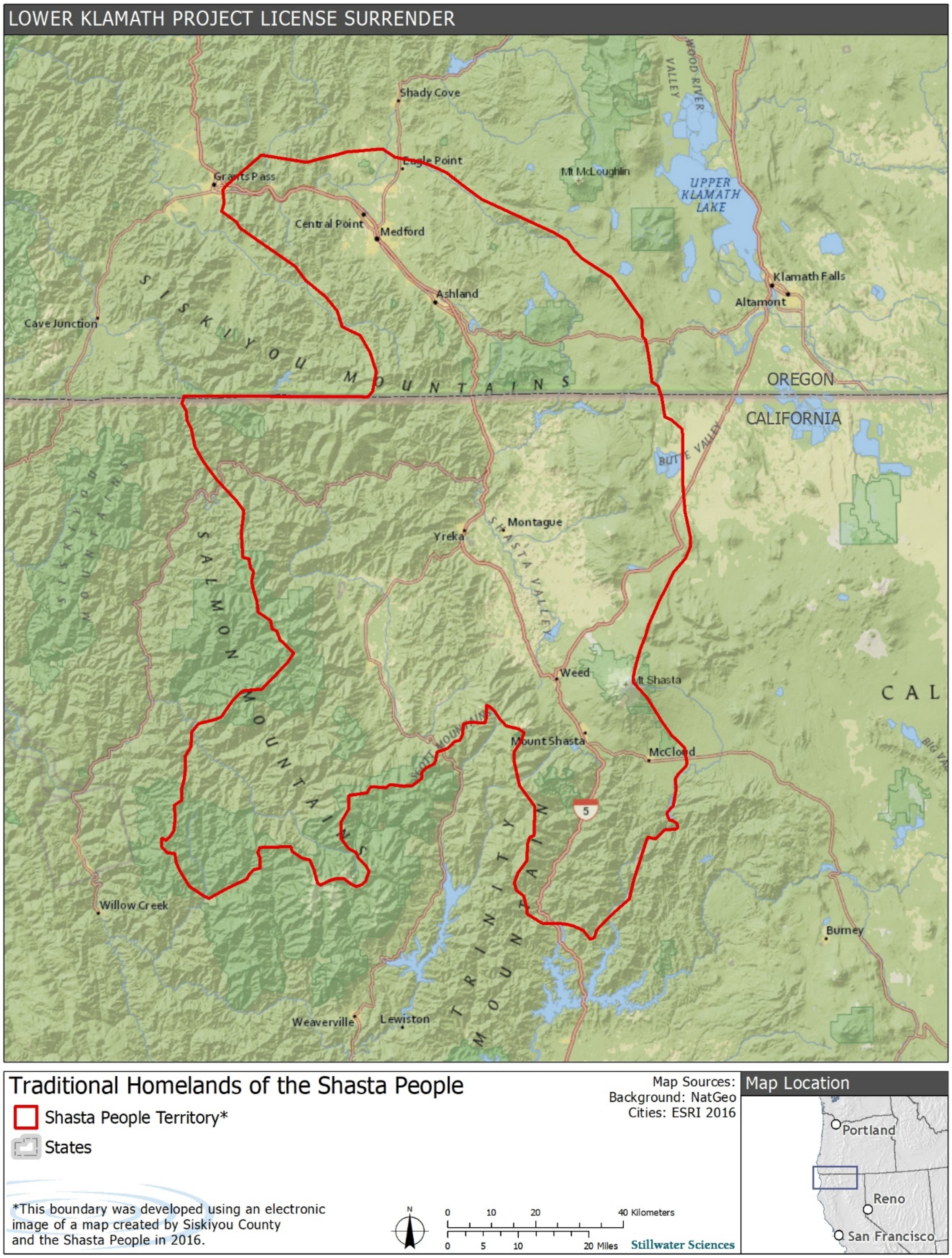

Figure 3.12-6. Traditional Homelands of the Shasta People. Map based on GIS interpretation of traditional Shasta People Homeland map provided by Shasta Nation and Siskiyou County.

There are several groups of Shasta that exhibit different cultural traits. Information presented here focuses on the Klamath River Shasta, called the Wiruhikwaiiruka or Kammatwa (Daniels 2006). Shasta were organized into autonomous tribelets consisting of extended family groups that occupied a group of villages. The family was the basic social unit of the Shasta, with the village being the political and economic unit. Each village had a chief/headman to provide leadership and organize important social, political, and economic events (Silver 1978). Shamans conducted a variety of ceremonies in villages, and the Shasta people considered Mount Shasta to be sacred ground that was used for healing, blessing, and ceremonies. Mount Shasta is a significant part of Shasta traditions and ceremonialism.

Shasta along the Klamath River tended to build their winter villages near the river. Villages had recognized territories with areas for each family, including fishing places with fish weirs along the Klamath. Hunting territories also were held privately over the long term, in contrast to tobacco-growing plots and acorn-gathering trees, which were claimed only for brief periods. Typical villages consisted of brush shelters, bark houses, sweathouses, assembly houses, and winter houses (Silver 1978). The major structures of a Shasta village included the dwelling house (umma), a big house (okwa-umma), the sweat house (wukwu), and the menstrual hut (wapsahumma) (Shasta Indian Nation 2018).

During the spring and summer, Shasta established temporary hunting and gathering camps in the foothills and mountains to make use of seasonally available resources in those ecological zones. Shasta relied on a subsistence pattern emphasizing gathering, hunting, and fishing, and use of a variety of plant and animal resources as they became seasonally available. For example, resources used by the Shasta included deer, brown bear, rabbit, and a variety of small mammals, fish, birds, insects, acorns, buckeye, pine nuts, manzanita berries, and a variety of other plants. Acorns were a staple of the Shasta diet. Regardless of the variety of resources available to the Shasta, the primary components of their diet were deer, Chinook salmon, and acorns (Dixon 1907, Silver 1978).

Individual hunters and communal hunting parties hunted deer using bows and arrows, snares, dogs, and drives (e.g., driving deer over cliffs). Waterfowl and quail were taken using nets, snares, and traps (Moratto 1984). Spring and fall salmon runs were important fishing times for the Shasta. Fishing techniques included a combination of techniques including nets, weirs, spears, and fish drives (Shasta Indian Nation 2018). In the spring, Klamath River Shasta waited to catch salmon until a member of another Shasta Group called the Kammatwa caught the first fish and performed a ritual. Klamath River Shasta could then catch and process the fish for storage but could not eat them until the Karuk performed the White Deerskin Dance ceremony. Salmon and trout were sun dried and stored in baskets for winter consumption (Silver 1978). Women and children also dove for mussels in the Klamath River during the spring.

Shasta traded pine nuts, obsidian blades, and juniper beads with their neighbors for obsidian from the Achumawi; pine nut necklaces from the Wintu; canoes from Karuk and Yurok; acorns, baskets, dentalia shells, haliotis shells, and other shells from the Karuk, Hupa[177], and Yurok; and beads from Wintu (Silver 1978). Shasta also acted as a middleman for the Achumawi, who acquired dentalia shells from groups in the Columbia River area. In addition, Shasta occasionally attended Karuk, Hupa, and Yurok dances.

Euro American settlement into Shasta lands accelerated as a result of the Gold Rush. Conflicts between Indian Tribes and Euro Americans resulted in the Rogue River Indian Wars of 1850–1857 that pushed Shasta from their traditional fishing, hunting, and village sites. A treaty in 1851 established a reservation in Scott Valley for Shasta, but conflict between Euro Americans and Shasta persisted. Consequently, in the 1870s Shasta welcomed cultural revivalist movements such as the Ghost Dance. From the 1870s through the 1940s most Shasta in the vicinity of the Proposed Project lived at the Frain Ranch or Bogus Tom Smith's Rancheria (Daniels 2006) and continued to practice their traditional subsistence activities. Currently, Shasta are represented in the Shasta Nation, Shasta Indian Nation, and the Etna Band of Indians otherwise known as the Ruffey Rancheria. Along with working on federal recognition, through the Ruffey Rancheria Restoration Act (HR 3535, La Malfa 2017), the Shasta people continue to preserve, protect, and maintain traditional cultural practices, including sites associated with those practices.

Northwest California Culture Area

King et al. (2016) identified six patterns or modes of adaptation (i.e., Post, Borax Lake, Berkeley, Mendocino, Tuluwat, and Augustine Patterns) for northwest California and the North Coast Ranges and assigned them to six time periods: Paleo-Indian (10,000–6,000 B.C.); Lower, Middle, and Upper Archaic (6,000 B.C.–A.D. 500); and Upper and Lower Emergent (A.D. 500–1800) periods. The patterns applicable to northwest California are the Post, Borax Lake, Mendocino, and Tuluwat (formerly Gunther).

The Post Pattern (12,000–8,000 BP) represents the earliest occupation of the area and is characterized by fluted, concave-base projectile points and crescents. Regardless, archaeological sites with well-defined assemblage of typical Post Pattern artifacts are not well represented in northwest California.

The Borax Lake Pattern (8,000–2,500 BP) represents a generalized hunting and gathering subsistence pattern. It is characterized by heavy, wide-stemmed points with indented bases, serrated bifaces, ovoid tools, hand stones, and milling slabs (King et al. 2016). The Borax Lake Pattern is identified at sites across a wide variety of environments in Humboldt and Trinity counties along Pilot Ridge and South Fork Mountain and along a river terrace adjacent to the Trinity River. One archaeological site has a house floor and post holes dated over 7,000 BP (Fitzgerald and Hildebrandt 2001).

The Mendocino Pattern (5,000–1,500 BP) appears to represent a hunting and gathering subsistence pattern that is well adapted to local environments and typically exploits seasonally available resources across different ecological zones. It is characterized by side-notched, corner-notched, and concave base dart points, hand stones, milling slabs, and in some cases small numbers of cobble mortar and pestles. The Mendocino Pattern is not clearly defined in northwestern California, but it has been identified at sites on Point St. George, and along the Smith River, in Humboldt Bay, and in the northern mountains of Humboldt County (King et al. 2016).

The Tuluwat Pattern (beginning about 1,500 years BP) appears to be associated with the exploitation of marine and riverine resources. It is characterized by barbed projectile points, concave based points used for composite harpoons, spears, hooks ground and polished stone artifacts, flanged pestles, notched net sinkers, and steatite bowls.

Sites representing this settlement pattern are associated with exploitation of marine mammals and fish and include locations in Del Norte and Humboldt Counties (King et al. 2016). The pattern appears to represent the earliest evidence of subsistence patterns associated with the exploitation of marine mammals and fish that is typical of the Yurok, Hupa, and Karuk that currently inhabit northwest California and the Klamath Basin.

Ethnography

Karuk: Bright (1978) summarizes ethnographic information regarding Karuk primarily from information presented by Gifford (1939a,b; 1940) and Kroeber and Barrett (1910). Karuk occupy territory west of the Shasta, which stretches along the Middle Klamath River near the western boundary of Siskiyou County from Seiad to Bluff Creek just west of Orleans (Bright 1978). The Karuk Tribe has been federally recognized since 1979 and occupies territory along the Middle Klamath River. Karuk are members of the Hokan language family (Bright 1978). Karuk share similar cultural traits with the Yurok and Hupa and regularly interact with each other.

Karuk were organized in villages with a relatively loose political structure. The acquisition of wealth is an important part of Karuk culture, and wealthy men assumed leadership roles because of their prestige. Villages varied in size and consisted of rectangular cedar plank houses and sweat houses. Karuk focused on the use of fish and aquatic resources, but other terrestrial resources were also important supplements to their diet. Karuk also harvested acorns and hunted in upland areas around the Klamath River for deer, elk, birds, and fur bearing mammals. The hides of mammals were used for a variety of clothing and bird feathers and pelts were used for ceremonial regalia.

Plentiful fish resources facilitated the occupation of numerous villages along the Klamath and Salmon Rivers (i.e., Salter [2003] reports that 100 villages existed along the two rivers). The villages were in advantageous locations on bends of the Klamath River and bluffs above it, such as near the mouths of Camp Creek (Tishawnik), the Salmon River (Mashuashav), and Clear Creek (Inam).

Archaeologically, Karuk tools reflect their emphasis on the acquisition of fish and other aquatic resources and include harpoons, nets, and hooks. Facilities constructed to harvest fish include weirs, dams, and fishing platforms. Karuk also constructed canoes from hollowed out logs for fishing and transportation along the Klamath River and its tributaries. Transportation along the river and streams was essential to Karuk ceremonial activity. Indeed, Karuk traditions state that the Klamath River was created to facilitate their interaction with Yurok and Hupa and with salmon.

The political and social organization and material cultural of the Karuk are important topics, but their religious and ceremonial practices highlight their relationship to the Klamath River and its associated resources. Of particular importance are world renewal ceremonies and ceremonies for bountiful harvests of fish and other resources (Bright 1978). World renewal ceremonies include the White Deerskin and Jump ceremonies at which the earth and the creator are honored for providing food and facilitating the prosperity of the tribes. These ceremonies were and continue to be conducted at sites along the Klamath River such as Panamnik (Drucker 1936, Verwayen and Hillman 2010). Ceremonies to insure harvests of fish include the First Fish, First Salmon, and Fish Dam ceremonies. Other ceremonies related to world renewal and curing are the

Boat Dance and the Brush Dance. Karuk, Hupa, and Yurok regularly attend each other's ceremonies and the ceremonies are conducted for the benefit of all the groups.

The White Deerskin and Jump ceremonies honor the earth and the creator for providing food resources and maintaining the tribes. The White Deerskin ceremony is held from late August into September, depending on the river and its waters. The Jump ceremony is conducted after the conclusion of the White Deerskin ceremony and is also held for the "good" of the world. Both the White Deerskin and the Jump ceremonies depend on a healthy Klamath River system for fish, basket materials, and bathing. The First Fish ceremony is conducted in spring and the Fish Dam ceremony is conducted to in mid-summer to celebrate the harvesting of fish and to pray for continuing prosperity and access to subsistence resources, primarily fish resources. The Boat ceremony forms part of the White Deerskin ceremony, celebrating the flows and health of the rivers. The Brush Dance is held to cure the sick, particularly children.

Euro American settlement in the Area of Analysis for historical and tribal cultural resources accelerated as a result of the California Gold Rush. Conflicts between Indian Tribes and Euro Americans were commonplace across Karuk territory. Consequently, Karuk welcomed cultural revivalist movements in the 1870s such as the Ghost Dance, but traditional cultural practices and numbers of Karuk continued to decline. Regardless, the Karuk persisted and contemporary Karuk continue to practice their traditional activities and are actively engaged in programs related to improving the health of the Klamath River and its fishery.

Quartz Valley Indian Community

The Quartz Valley Community is a federally recognized tribe mainly representing people of Karuk and Shasta ancestry, with 174 acres of reservation lands in the Scott Valley, near Fort Jones, California. Their cultural history is similar to that described for the Karuk, as most members are of Karuk ancestry (Appendix V – 2012 KHSA EIS/EIR *Section 3.12 Tribal Trust*). The Quartz Valley Indian Community's reservation lands are located near the community of Fort Jones. The Quartz Valley Indian Community initially filed their constitution and bylaws with the Office of Indian Affairs in 1939 (DOI 1939).

Yurok

Pilling (1978) summarizes ethnographic information regarding Yurok collected by Waterman (1920), Waterman and Kroeber (1934), and others. Sloan (2003, 2011) also presents a summary of the ethnography of the Yurok and the relationship to the tribe to the Klamath River. Yurok are members of the Algonquian language family. Yurok ancestral territory extends along the Pacific coast of California from Crescent City in the north to Trinidad in the south and along the Klamath River from the coast to a point near the confluence of the Klamath and Trinity Rivers and the town of Weitchpec (Pilling 1978). The Yurok Tribe's reservation currently consists of a strip of land beginning at the Pacific Ocean and extending a mile along each side of the Klamath River approximately 45 miles.

The Yurok life, language, ceremonies, society, and economy are linked with the Klamath River. There are Yurok stories that reinforce the Yurok belief that the River was created in a distinct way in order to provide Yurok people with the best of worlds (Sloan 2003, 2011). Yurok refer to the river as HeL kik a wroi or "watercourse coming from way back in the mountains." Contemporary Yurok often refer to the Klamath River as the "Yurok Highway" emphasizing its comparison to a blood vessel that provides the main flow of sustenance. Karuk, Yurok, and Hupa share similar cultural traits and traditional stories state that the Klamath River was created to facilitate their interaction with each other and with salmon.

The Yurok had permanent settlements with substantial architectural features including houses, smokehouses, and storage facilities (Kroeber and Barrett 1910, Pilling 1978). Pilling (1978) cites 44 villages, 97 fishing spots, 82 significant cultural places (e.g., places used for ceremonies, gathering, and hunting), and 41 places of cultural significance along the Klamath River in Yurok territory.

The Yurok represent a socially complex hunter-gatherer population in California (Fredrickson 1984, Kroeber 1925) that used marine and salmon resources. Organizing labor to capture the short-duration salmon runs, preserving fish by smoking, then packing and storing the fish suggests a high degree of sociopolitical differentiation. There is also evidence of a maritime expression to Yurok culture involving marine mammal hunting more than 10 miles offshore. The most telling argument for an open-ocean maritime adaptation comes from the presence of the large amount of northern fur seal fauna in the Stone Lagoon midden. Jones and Hildebrandt (1995) argued that pinnipeds were extirpated early on shore by Native Americans, who then developed watercraft to hunt offshore.

The material culture of the Yurok people includes, to this day, dugout redwood canoes, split-plank houses, storage boxes, sweathouse pillows and stools, many fishing devices, baskets and leather, shell, straw and feather garments and ceremonial regalia.

Transportation along the rivers and streams is essential to Yurok ceremonial activity. One of the most important aspects of Yurok technology was the river- and ocean-going canoe or yoch, which were carved from selected redwood trees (Sloan 2003, 2011). There are historic accounts of expeditions traveling up to 180 miles along the coast (Sloan 2003, 2011). A typical river canoe measured 16 to 20 feet in length and 3 to 4 feet in width. River canoes were customarily paddled and/or pushed with a long pole. Yurok technology and facilities do not only serve utilitarian functions, but also include ceremonial aspects of Yurok culture. For example, facilities, such as fishing weirs, were created specifically to signify the time of sacred ceremonies (e.g., the White Deerskin and Jump ceremonies).

Fishing places along the Klamath River are owned by individuals, families, or groups of individuals. Fishing places can be borrowed, leased, inherited, or bought and sold (Sloan 2003, 2011). Some ownership rights at fishing places depended on species of fish caught at the site, while others depended on the water level (i.e., individuals owned the right to fish at a place if the river was below or above a certain level). Yurok still recognize this traditional form of resource management and use of the river. Families and individuals continue to use and own rights to fishing places on the Klamath River.

Like the Karuk, the religious and ceremonial practices highlight the Yurok relationship to the Klamath River and its associated resources. Of particular importance were the Jump, White Deerskin, Boat, and Brush ceremonies. The Jump and White Deerskin ceremonies were held in late fall to give thanks for food resources abundance collected during the year and to insure a continued abundance of food resources for the next year (Sloan 2003, 2011). Affluent individuals and religious leaders conduct most ceremonies, and wealthy individuals were expected to feed salmon to everyone attending the ceremonies.

The Boat Ceremony is part of the White Deerskin Ceremony. In this ceremony, several boats filled with participants travel down the Klamath River. The participants thank the river for continuing to flow and provide resources. The Brush Ceremony unfolds over a four-day period and highlights the importance of Klamath River resources to Yurok. For example, baskets made of plant materials collected at the water's edge are used to hold food and ceremonial medicine; acorns are cooked in the baskets using cooking stones gathered at specific river bars; ceremonial regalia is made from various plant and animals that live along the river; ceremonial bathing is performed; and participants listen to the sounds made by the Klamath River (King 2004).

The social and ceremonial significance of the Klamath River is evident in and reinforced by Yurok traditions. For example, there are at least 77 Yurok stories that make direct reference to the Klamath River (Sloan 2003, 2011). These Yurok stories reinforce the belief that the Klamath River was created to provide Yurok with a very good place to live.

Spanish explorers and vessels traveling from the Philippines may have interacted with Yurok along the coast in the late 1700s. Other explorers such as Peter Skene Odgen and Jedediah Smith certainly encountered Yurok along the Klamath River in the early 1800s. Regardless, Euro American settlement and use of Yurok territory did not begin until after the discovery of gold in California in early 1850. With strikes along the Klamath and Trinity rivers, gold prospectors inundated the region affecting Yurok traditional culture (Pilling 1978).

In 1851 a "Treaty of Peace and Friendship" was signed between the United States Government and the Klamath River Indians, but the United States Congress did not ratify this treaty. Subsequently, on November 16, 1855, the Klamath River Reserve, also known as the Klamath Indian Reservation, was established by Executive Order. The Order designated the reservation lands from the mouth of the Klamath River, one mile on each side extending approximately 20 miles upriver to Tectah Creek (Sloan 2003, 2011).

Escalating conflict between Yurok and Euro Americans during the 1860s and 1870s over encroachment onto the Klamath Indian Reservation resulted in the gradual displacement of Lower Klamath Indians further upriver (Sloan 2003, 2011). Euro Americans on the reserve resisted attempts to remove them, including eviction in 1879 by the United States Army (Sloan 2003, 2011). After decades of struggle to regain their traditional homelands, the Yurok Tribe was re-organized and was granted its own reservation in 1988. As a result of the 1988 Hoopa-Yurok Settlement Act (PL-100-580), the Yurok Indian Reservation was established.

The ancestral lands of the Yurok Tribe extend unbroken along the Pacific Ocean coast (including usual and customary off-shore fishing areas) from Damnation Creek, its northern boundary, to the southern boundary of the Little River drainage basin, and unbroken along the Klamath River, including both sides to the associated tributary watershed boundaries from the mouth upstream to the Bluff Creek drainage basin. The Yurok Tribe considers cultural resources sites along and associated with the Klamath River to be part of a larger ethnographic riverscape (King 2004, Yurok Tribe 2012). Sites include fishing areas; a fish dam (weir) site; many different types of resource gathering sites, complex trail systems that connect villages, camps, the river, ceremonial sites, gathering areas, and other Tribes; and 47 villages with graves/cemeteries.

The Yurok Tribe is the largest tribe in California, with over 4,500 enrolled tribal members and over 200 tribal government employees. The Yurok Tribe is actively pursuing economic development and management of fisheries, forestry, and cultural programs, both on the reservation and Yurok ancestral lands.

Resighini Rancheria: The Resighini Rancheria is located on the southern banks of the Klamath River Estuary, surrounded by the Yurok Reservation. The tribe is composed of Yurok ancestry and has a very similar cultural history to that of greater Yurok culture. Land known as the Resighini Rancheria was designated by Secretarial Order and was officially declared a reservation in 1939. In 1975, a group of Yurok Indians stood together and formally created a non-traditional form of government with a constitution and bylaws which was approved and ratified by the last Indian Commissioner Bruce Thompson from the Department of Interior of the United States. However, the disastrous flooding of 1964 (see also Figure 3.6-14) led to the temporary evacuation of Resighini Rancheria.

Today, the tribal government consists of a General Council with an elected Tribal Council to operate our governmental and private tribal affairs as well as represent the tribal needs of our small membership. The Tribal Council consists of five tribal members who are elected annually by staggered two-year terms of Chairman, Vice Chairman, Secretary, Treasurer and Councilperson. Their general membership serves on boards, committees, commission and corporations to assist the Tribal Council.

Hoopa Valley Tribe: Wallace (1978) summarizes ethnographic information regarding Hupa primarily collected by Goddard (1903). Hupa are members of the Athabascan language family and they call themselves Natinixwe. Hupa ancestral territory is centered in Hoopa Valley and the area surrounding the Trinity River near its confluence with the Klamath River. Hupa, Karuk, and Yurok share similar cultural traits and regularly interact with each other.

Hupa were organized in villages with a relatively loose political structure. Villages typically consisted of family groups (Wallace 1978). Villages varied in size and consisted of rectangular cedar plank houses. For substances, traditional Hupa people primarily used fish and aquatic resources, but also utilized terrestrial resources such as mammals, birds, reptiles insects, and other fauna (Wallace 1978). Hupa also harvest acorns and hunted in upland areas around the Trinity and Klamath River for deer, elk, birds, and fur-bearing mammals. The hides of mammals were used for a variety of clothing and bird feathers and pelts are used for ceremonial regalia.

Hupa tools reflect their emphasis on the acquisition of fish and other aquatic resources and include harpoons, nets, and hooks. Facilities constructed to harvest fish include weirs and dams. The Hupa used canoes for fishing and transportation along the Trinity and Klamath rivers but obtained their canoes from the Yurok. Transportation along the river and streams was essential to Hupa ceremonial activity.

Like the Karuk and the Yurok, the Hupa's religious and ceremonial practices highlight their relationship to a river, the Trinity River, and its associated resources. Of particular importance are world renewal ceremonies and ceremonies for bountiful harvests of fish and other resources (Wallace 1978). World renewal ceremonies include the White Deerskin and Jump ceremonies at which the earth and the creator are honored for providing food and facilitating the prosperity of the tribes. Ceremonies to ensure harvests of fish and acorns include the First Salmon ceremony and Acorn Feast (Wallace 1978). Hupa, Karuk, and Yurok regularly attend each other's ceremonies and the ceremonies are conducted for the benefit of all the groups.

Euro American settlement of the as a result of the Gold Rush, ultimately resulting in the establishment of the original Hoopa Valley Reservation in 1864. President Harrison expanded the Hoopa Valley Indian Reservation in 1891 to include the Klamath River Reserve that extended one mile on either side of the Klamath River from the Pacific Ocean for 22 miles upstream, as well as the lands one mile on either side of the river between the two reservations (Salter 2003). The 1988 Hoopa-Yurok Settlement Act (PL-100-580) divided the reservation again, separating it into the Hoopa Valley Reservation and the Yurok Indian Reservation (Salter 2003).

The culture of Karuk, Hupa, and Yurok is closely tied to the Klamath and Trinity Rivers. These tribes subsist wholly or in large part on the resources acquired from the river, most of their sacred sites are located along it, and their cultural traditions are related to it (Bright 1978, Pilling 1978, Wallace 1978). Contemporary Hupa practice their traditional activities and are actively engaged in programs related to improving the health of the Trinity River and its fishery.

3.12.2.2 Historic Period

Euro American exploration of the Klamath region began in the early 19th century. Jedediah Strong Smith and Peter Skene Ogden explored current Siskiyou and Klamath County in 1826 and 1827 for beaver as part of fur trade, and in 1829 a party of Hudson Bay Company trappers and explorers, led by Alexander Roderick McLeod, also passed through the area (Klamath Hydroelectric Project 2004). The fur trade ended in the mid-1840s. Largely, the area remained sparsely occupied by Euro Americans until the mid-1800s, when mining and logging attracted settlers to the area.

The discovery of gold at Sutter's Mill in Coloma in 1848 was the catalyst that caused a dramatic alteration of both Native American and Euro American cultural patterns in California. A flood of immigrants entered the California and the Klamath region once news of the discovery of gold spread. Initially, the Euro American population grew slowly, but soon exploded as the presence of large deposits of gold were confirmed. The non-Native American population of California quickly swelled from an estimated 4,000 Euro Americans in 1848 to 500,000 in 1850 (Bancroft 1888). The discovery of gold and the large influx of primarily Euro American immigrants had a positive effect on the growth and economic development of California as a state, but a negative effect on Native American cultures. The discovery of gold in California marked the beginning of a relatively rapid decline of both Native American populations and culture. The influx of primarily European Americans displaced Native Americans from their traditional territory, discouraged the use of traditional languages and the practice of religious ceremonies, and Euro American economic pursuits (e.g., gold mining, logging, ranching, and farming) limited the practice of traditional subsistence activities.

Gold was discovered by Abraham Thompson and his party just north of the present-day location of the City of Yreka in 1851 (Hoover et al. 2002). Known as "Thompson's Dry

Diggins", the population quickly exploded to 2,000 miners, and the town of Shasta Plains was established (Hoover et al. 2002). The town primarily included tents and brush shanties, but also included a saloon built out of shakes and canvas by Sam Lockhart. The first permanent house in the town was built by D.H. Lowry and his wife.

Euro American settlement in the Klamath River watershed continued to grow through the 1850s due to the completion of roads such as the Southern Emigrant Road, also known as the Applegate Trail, in 1846 (Klamath Hydroelectric Project 2004). These roads brought prospectors to the region and helped to establish communities such as Henley (Cottonwood), Gottville, Happy Camp, and Somes Bar. Fertile soil and plentiful water sources provided opportunities for homesteading and the private development of agriculture and ranching, particularly in the area around current Upper Klamath Lake, but also extending downriver, occupying the rich alluvial terraces along the river through the canyon. The expansion of Euro Americans in southeastern Oregon resulted in execution of treaties with the various Klamath River tribes and the relocation of these groups in the area (Klamath Hydroelectric Project 2004). Shasta women married into ranching families at this time and are recognized as being instrumental in the tribes' long-term survival today.

Logging began in the Klamath Basin in the 1860s and sustained logging enterprises appeared in the 1880s (Klamath Hydroelectric Project 2004). Early companies were generally small, family-run operations managed by ranching families trying to supplement their income. In 1867, President Ulysses S. Grant signed legislation to create a land-grant subsidy for the construction of the Oregon and California Railroad (Klamath Hydroelectric Project 2004). The grant allowed the Oregon and California Railroad Company to select off-numbered sections from the public domain for the construction of the railroad. In 1887, the Oregon and California Railroad Company claimed "lieu" lands on the Pokegama Plateau as compensation for other lands that had already been claimed by homesteaders or military and wagon road companies. Title to these lieu lands were immediately (and illegally) transferred to the Pokegama Sugar Pine Lumber Company. To move the logs from the Pokegama Plateau, the Pokegama Sugar Pine Lumber Company built a log chute on the rim of the Klamath River Canyon and the first railroad in Klamath County (Gavin 2003). During this period, larger scale logging companies such as Pokegama Sugar Pine Lumber Company and Klamath River Lumber and Improvement Company were established on the north rim of the Klamath River Canyon.

The end of the nineteenth and beginning of the twentieth centuries witnessed an ongoing and growing immigration into the area, which was facilitated by the construction of the railroad through the region. The railroad provided a reliable means of transportation in the area and stimulated regional cultural and economic development. In addition to improving transportation, a railroad grade constructed at the northern end of Lower Klamath Lake functioned as a dike that facilitated drainage of wetlands for agriculture and control of the flow of water from the Klamath River.

The Oregon and California Railroad constructed in 1877 was the first railway through the region (Klamath Hydroelectric Project 2004). It extended from Siskiyou County, California, to Jackson County, Oregon, and facilitated travel and the transport of goods between Sacramento and Portland. Subsequently, the Southern Pacific Railroad Company acquired the Oregon and California Railroad, and by 1909 agricultural and lumber products of the Klamath Basin could be distributed to a nationwide market.

The first hydroelectric development in the Klamath Basin was established in 1891 in the Shasta River Canyon below Yreka Creek to provide electricity to the City of Yreka (Klamath Hydroelectric Project 2004). Four years later, in 1895, the Klamath Falls Light & Water Company built a power plant along the banks of the Link River and soon thereafter began power generation for the town of Klamath Falls (Klamath Hydroelectric Project 2004). The first decade of the 20th century brought a number of mergers and reorganizations of power companies in the specific project reach of Klamath River canyon currently under study. The California-Oregon Power Company (COPCO) was one of the companies that emerged from this period of reorganization (Klamath Hydroelectric Project 2004). The USBR's Klamath Irrigation Project, authorized in 1905, was developed by the DOI to supply farmers with irrigation water and farmland in the Klamath Basin. Link River Dam is the principal source of water for Reclamation's Klamath Project and the irrigation system and serviced areas are situated upriver of the Proposed Project.

COPCO proposed to develop hydroelectric power facilities along the Klamath River. Residents in the Klamath Falls area were divided over COPCO's proposal to dam and generate power on the river. Farmers feared the depletion of precious irrigation water while other businesses saw COPCO operations as an addition to the local economy. Regardless, with the increasing power needs of both irrigation and lumber mills and a huge influx of military personnel stationed at Medford and Klamath Falls, it was only a matter of time before additional power generation facilities were needed in the area. Envisioned in 1911, the Klamath Hydroelectric Project (Klamath Hydroelectric Project) was built in phases through 1962 (Kramer 2003a,b). Klamath Hydroelectric Project facilities were constructed by COPCO beginning with Copco No. 1 Dam (1918), followed by Copco No. 2 Dam (1925), and reconstruction of the old East Side facility in 1924. After World War II, regional population growth prompted a new round of hydroelectric power expansion highlighted by COPCO's Big Bend project (J.C. Boyle Dam and powerhouse) in 1958 and the construction of the Iron Gate facilities in 1962. While the Iron Gate facilities were still under construction, COPCO merged with Pacific Power & Light, currently PacifiCorp. PacifiCorp currently owns and operates the Klamath Hydroelectric Project.

The development of the Klamath Hydroelectric Project played a significant role in the area's economic development, both as part of a regionally significant, locally owned and operated private utility and through the role that increased electrical capacity played in the expansion of the timber, agriculture, and recreation industries during the first six decades of the 20th century. The Klamath Hydroelectric Project dams and associated facilities are recommended as eligible for inclusion on the National Register of Historic Places (NRHP) as the Klamath Hydroelectric Historic District (KHHD) under Criterion A for its association with the industrial and economic development of southern Oregon and northern California from 1903–1962 (Kramer 2003a,b; Cardno Entrix 2012). Economic development continues in the region, but it is now driven by tourism and recreation rather than gold mining, agriculture, or logging.

3.12.2.3 Known Tribal and Historical Resources in the Vicinity of the Proposed Project

Summary of California Historical Resources Information System Record Searches

In 2017, the KRRC conducted an updated records search at the California Historical Resources Information System's Northeast center at Chico, State University, for a study area that includes the length of the Klamath River from the Oregon-California state line, 40 miles downstream to Humbug Creek. The section of river below Iron Gate Dam (the most downstream Lower Klamath Project dam) was included in the records search since this 18-mile long area lies within the altered FEMA 100-year floodplain following dam removal, where cultural resources have the potential to be affected. The records search area included a 0.5-mile wide buffer, extending on either side of the shorelines of Copco No. 1 Reservoir and Iron Gate Reservoir, and from the center point of the Klamath River in all other areas.

The KRRC's 2017 record search compliments the cultural resource record searches previously performed as part of the Klamath Hydroelectric Project Relicensing (FERC 2007) and 2012 KHSA EIS/EIR studies (PacifiCorp [2004] and Cardno Entrix [2012]).

The records search included gathering archaeological site forms, survey and excavation reports, maps, and other records. Survey and site locations were hand plotted onto USGS topographic maps at the Northeast Information Center. Research of historic registers included the California Historic Landmarks, National Register of Historic Places (NRHP), California Register of Historical Resources, California Points of Historical Interest, California Inventory of Historic Resources, and the California State Historic Resources Inventory. In April 2017, the KRRC visited the Klamath National Forest office and the Siskiyou County Museum, both in Yreka, California to collect additional historic information. Klamath National Forest Heritage Program Manager Jeanne Goetz conducted a search of records for Forest Service lands within or near the KRRC records search area and provided appropriate archaeological site record forms (Appendix B: *Definite Plan – Appendix L*).

The KRRC also conducted a background literature search to identify known cultural resources and also to determine the types of cultural resources likely to occur within the area of the Proposed Project. In addition, online newspaper archives were searched, including the National Digital Newspaper Program archives provided by the Library of Congress and National Endowment for the Humanities (www.chroniclingamerica.loc.gov); Genealogy Bank newspaper archives provided by NewsBank, Inc. (www.geneaologybank.com); the California Digital Newspaper Collection repository provided by University of California, Riverside (www.cdnc.ucr.edu); and newspaper archives provided by www.Ancestry.com.

In May 2017, the KRRC obtained cultural sources data from PacifiCorp, including GIS shapefiles with previous survey and resource locations, as well as, a copy of the final cultural resources technical report prepared for Klamath Hydroelectric Project relicensing (PacifiCorp 2004). In addition, the KRRC contacted Dr. Joanne Mack, Professor Emeritus at Notre Dame University, a primary researcher in the Upper Klamath Basin, to discuss the Proposed Project and to learn of her on-going research in the area that might not be reflected in published or unpublished literature. The KRRC also consulted with Dr. Brian Daniels, Director of Research and Programs for the Penn Cultural Heritage Center at the University of Pennsylvania Museum, regarding ethnographic information, archival documents, and oral histories pertaining to tribal cultural resources within the California records search area.

The KRRC contacted the Native American Heritage Commission in June 2017, to secure a review of the Sacred Lands file for a 0.5-mile wide area on either side of the Klamath River corridor, extending from the California-Oregon state line downstream to the Pacific Ocean. In a June 14, 2017 letter, the Native American Heritage Commission stated that there was a positive result, with the recommendation to contact the Karuk Tribe, Yurok Tribe, and Shasta Nation. The Native American Heritage Commission also provided a consultation list of 29 tribes with traditional lands or cultural places located within the boundaries of Del Norte, Humboldt, and Siskiyou counties.

The KRRC records search and literature review (Appendix B: *Definite Plan – Appendix L*) identified that 58 previous cultural resources investigations have been conducted within the records search study area, with five studies (Kramer 2003a,b; Cardno Entrix 2012; Durio 2003; PacifiCorp 2004) completed specifically for the Proposed Project (Appendix B: *Definite Plan – Appendix L*). Several of these studies are archaeological, ethnographic, or historical overviews, while others describe the findings of specific archaeological excavations.

The majority of the past surveys involve pedestrian field survey and cultural resources monitoring. Overall, an estimated 8,189 acres of federal, state, and/or private land have been previously surveyed within the records search area and except for some proposed disposal sites, encompasses the current boundaries of the Proposed Project.

The KRRC California record searches identified 206 previously recorded cultural resources, consisting of 120 archaeological sites,1 ethnographic property, 9 built environment resources, 68 isolated finds, and 8 resources of an undetermined resources type (Appendix B: *Definite Plan – Appendix L*). By type, these resources include 114 prehistoric, 59 historic-period, 23 multiple-component (prehistoric and historic period), 1 ethnographic property, and 9 resources whose temporal association is unknown.

Archaeological Sites

The known archaeological sites on file at the Northeast Information Center represent roughly 60 percent of the previously recorded resources along the Klamath River from the Oregon-California state line to Humbug Creek. The sites consist of 49 prehistoric, 48 historic-period, and 23 multiple-component (both historic and pre-historic at the same location) sites. Identified prehistoric period sites include villages; campsites; lithic scatters; lithic scatters with associated cultural features; toolstone quarries; a possible ceremonial site with multiple features; and a human burial site.

The historic-period archaeological sites consist of late-nineteenth or early-twentieth century properties associated with the development of agriculture, including settlements or features such as homesteads; logging; mining; commercial; public works (hydroelectric); and transportation. Agricultural-related sites include settlements (homesteads), irrigation ditches, rock features, and artifact scatters.

Logging-related sites focus on elements of the former Klamathon townsite, including the town and lumber mill and the associated Pokegama log chute and ditch flume. Mining related sites, located in the Klamath River area below Hornbrook, include two quartz mines and four placer mines with ditches and/or tailings. The Beswick Hotel, ranch, and

Klamath Hot Springs area represents the single commercial property. An extensive refuse scatter associated with the Copco No. 1 Village is the sole public works site. Finally, transportation-related sites consist of an abandoned segment of the Klamath Lake Railroad, a collapsed trestle and segment of railroad grade, a segment of Topsy Road, a road leading to Horseshoe Ranch, and a segment of the California-Oregon Stage Road.

The multiple component sites include both prehistoric and historic-period components. Prehistoric components associated with these sites include housepit villages, a housepit village with a documented historic-period cemetery, lithic scatters, a toolstone quarry, and a rockshelter. Historic-period components comprise mining camps and/or tailings features, agricultural related resources such as historic ranches and artifact scatters, and a possible commercial property associated with a former saloon.

Table 3.12-1. Non-confidential Historic-period Cultural Resources within the Area of Analysis.[1]

Primary No.	State Trinomial	Resource Type	Site Type	General Vicinity	NRHP Eligibility
P-47-000522	CA-SIS-522	Site	Empire Quartz Mine	below IGR	7
P-47-000536	CA-SIS-536H, CA-SIS-1315H	Site	Klamathon Townsite and Lumber Mill	below IGR	7
P-47-001671	CA-SIS-1671H	Site	Klamath Lake Railroad Grade	on hillslope	7
P-47-002129	CA-SIS-2129H	Site	Grieve-Miller-DeSoza Ditch	on hill slope	3
P-47-002239	CA-SIS-2239H	Site	COPCO II Ranch Features	on hill slope	4S2
P-47-002266	CA-SIS-2266H	Built Environment	Copco II Powerhouse	Copco Dam	3S
P-47-002267	CA-SIS-2267H	Built Environment	COPCO I Powerhouse and Dam	Copco dam	3S
P-47-002268	CA-SIS-2268H	Built Environment	Fall Creek Powerhouse	Fall Creek	3S
P-47-002823	CA-SIS-2823H	Built Environment	COPCO II Wooden Stave Penstock	In between Copco and IGR	3S
P-47-002824	CA-SIS-2824H	Site	COPCO Guest House	Copco dam	3S
P-47-003917	CA-SIS-3917H	Site	Refuse Scatter	Copco Dam	7
P-47-003922	CA-SIS-3922H	Site	COPCO Village Dump	Copco Dam	7
P-47-003934	CA-SIS-3934H	Site	Historical Cairns	edge of IGR	7
P-47-003937	CA-SIS-3937H	Site	Rock Wall	below IGR	7
P-47-003940	CA-SIS-3940H	Site	Franklin Homestead	edge of IGR	7
P-47-003942	CA-SIS-3942H	Site	Rock wall	edge of IGR	7
P-47-003943	CA-SIS-3943H	Site	Rock Wall	on hill slope	7
P-47-003945	CA-SIS-3945H	Site	Historical Cairns	edge of IGR	7
P-47-004212	N/A	Built Environment	Bridge	below IGR	7

Primary No.	State Trinomial	Resource Type	Site Type	General Vicinity	NRHP Eligibility
P-47-004427	N/A	Site	Habitation with Artifact Scatter and Features	below IGR	7
N/A	N/A	District	Klamath River Hydroelectric Project District	Lower Klamath Project facilities and associated structures	7

[1] Table 3.12-1 was developed based on Table 3.5-3 3 Previously Recorded Archaeological Sites and Built Environment Resources in the KRRC's September 30 CEQA Technical Submittal. Table 3.5-3 is included as Appendix W of this EIR, and is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/table3.5_3.pdf

* National Register of Historic Places (NRHP) Eligibility from Cardno ENTRIX (2012) and/or NEIC site records:
- 3: Appears eligible for listing in the National Register of Historic Places;
- 3S: Appears eligible for separate listing;
- 4S2: May become eligible for separate listing in the National Register of Historic Places when more historical or architectural research is performed on the property;
- 7: Not evaluated.
- 8. Eligibility determinations were not made for all historic-period cultural resources listed in this table, but all historic-period cultural resources listed in this table are considered during impact analysis evaluation.

The site recorded solely as an ethnographic property consists of a natural rock landform in the Iron Gate area that features prominently in the cultural history of Shasta tribes. A group of eight sites, termed the Pollock Sites, represents undetermined site components.

Information provided in Table 6-8 in Appendix B: *Definite Plan – Appendix* L regarding the National Register of Historic Places eligibility of the archaeological sites is based on recommendations provided by Cardno Entrix (2012), or by eligibility information noted on site records that were not part of the Cardno Entrix study. Overall, one site is listed in the National Register of Historic Places as a contributor to a district, one site is individually eligible, three sites are contributors to a district, determined eligible, 29 sites appear eligible for listing, 2 sites might become eligible for listing when more historical research is performed; 4 sites have been found ineligible, and the remaining 80 sites have not been evaluated for National Register of Historic Places eligibility.

During State Water Board AB 52 consultation with the Shasta Indian Nation and Shasta Nation it was agreed that tribal cultural resources reflected in PacifiCorp (2004) and Daniels (2006), qualify as tribal cultural resources. Additionally, the Shasta Indian Nation provided updated tribal cultural resources information which is included in Confidential Appendix Q. A process to determine tribal cultural resource eligibility for previously unknown tribal cultural resources or refining understanding of existing tribal cultural resources following Proposed Project activities is discussed in Potential Impact 3.12-1.

Historical Built Environment Resources

The KRRC records search (Appendix B: *Definite Plan – Appendix L, Table 6-3*) identified nine historic-period built environment resources associated with the historic themes of commerce, settlement, transportation, and public works, as described below. The single commerce-themed resource includes a former service station converted to residence

(Klamath Kamp). Two settlement-related sites have been recorded, consisting of a post-1930s duplex residence with associated structures and the Frank Wood cabin, a late 1890s to 1950s era homesite. Transportation-related sites consist of a one-lane, wooden and steel beam truss bridge over the Klamath River (Ash Creek Bridge) west of Interstate 5, and the concrete State Route 263, T-beam bridge over the Klamath River at the confluence of Shasta River. Public works sites include four recorded elements of the Klamath Hydroelectric Project, including Copco No.1 Hydroelectric Powerhouse and Dam; Copco No. 2 Hydroelectric Powerhouse; Fall Creek Hydroelectric Powerhouse; and the Copco No. 2 Wooden Stave Penstock.

Besides these nine built environment resources, standing historic-period structures have been identified at several archaeological sites, including a ranch house and bunkhouse at the Beswick Hotel site (CA-SIS-513-H) and a shed at Copco II Ranch (CA-SIS-2239-H). The historic Spannaus Barn was noted at prehistoric/ethnographic site CA-SIS-2574, but was not recorded as an element of the site.

National Register of Historic Places eligibility information for these nine sites indicates that the two Klamath River bridges have been determined eligible for listing in the National Register of Historic Places. The four hydroelectric related sites were noted by Cardno Entrix (2012) as appearing eligible for separate listing, but these sites have also been documented as contributing elements to the Klamath Hydroelectric historic district (Kramer 2003b) which has yet to be concurred upon by the California and Oregon State Historic Preservation Officers. Also recommended as National Register of Historic Places eligible is the Frank Wood cabin. The final two resources, composed of a residence and a former service station, have been found ineligible for the National Register of Historic Places.

Isolated Finds

The KRRC records search (Appendix B: *Definite Plan – Appendix L, Table 6-3*) identified 68 individual resources not directly associated with sites (i.e., isolated finds or individual low-density concentrations of artifacts or features that do not appear to be associated with a larger site but could indicate Native American use of the area), including 65 prehistoric resources, 2 historic-period resources, and 1 isolated feature of unknown age. Prehistoric isolates include a rock cairn, bedrock milling feature, possible cupule boulders, an incised cobble, ground/battered stone and flaked stone artifacts. Forty-one isolate locations were found to contain flakestone manufacturing debris (debitage) ranging from 1 flake to as many as 13 flakes in a single location. Debitage includes obsidian, chert, and basalt. Eleven isolates contain both tools and debitage.

The historic-period isolates consist of one rusted horseshoe and the remains of a wagon. The isolate of unknown age is described as a rocky depression measuring 8.2 feet in diameter.

Potential Archaeological Districts

As part of the Klamath Hydroelectric Project relicensing study (FERC 2007), five areas containing multiple prehistoric sites were identified along the same section of the Klamath River which was considered as a potential National Register of Historic Places District (PacifiCorp 2004, FERC 2007). This potential district includes four groups of multiple sites in Oregon located at the head of Link River and the mouth of Upper Klamath Lake, Teeter's Landing, Spencer Creek/mouth of upper Klamath River Canyon, and near Frain Ranch. In California, a cluster of three villages near the headwaters to

Iron Gate Reservoir, comprised the fifth potential district group. The National Register of Historic Places eligibility of this district has not been finalized.

A historic-period archaeological district was also considered for the Frain Ranch, in Oregon (PacifiCorp 2004). Due to their association with early homesteading and the beginning of ranching and agriculture within the upper Klamath River, four Frain Ranch area sites were envisioned for this district. The National Register of Historic Places eligibility of this district has not been finalized at this time.

Potential Klamath River Hydroelectric Project District

The Klamath River Hydroelectric Project District comprises seven hydroelectric generation facilities and their related resources located along the Klamath River and its tributaries in Klamath County, Oregon and Siskiyou County, California. Beginning at the Link River Dam, in Klamath Falls, Oregon, the Project boundary continues southwest along the Klamath River to include the Keno Dam Complex and the J.C. Boyle Complex in Oregon. Within California, the Klamath Hydroelectric Project boundary includes the Fall Creek, Copco No. 1 and Copco No. 2 complexes, and terminating at Iron Gate Dam. The Klamath Hydroelectric Project facilities were constructed between 1903 and 1958 by the California Oregon Power Company (COPCO) and its predecessors and are now owned and operated by PacifiCorp under FERC License Nos. 2082 (Kramer 2003a,b) and 14803.

The proposed Klamath River Hydroelectric Project District includes the hydroelectric facilities and various diversion dams; support structures; linear elements such as flumes, canals, and tunnels; and other related buildings and structures. A historic context statement (Kramer 2003a) and Determination of Eligibility (Kramer 2003b) developed for the Klamath Hydroelectric Project notes its eligibility to the National Register of Historic Places as a District under Criterion A for its association with the industrial and economic development of southern Oregon and northern California (Kramer 2003b). The California and Oregon State Historic Preservation Officers have not concurred with this eligibility recommendation. Table 6-11 of Appendix B: *Definite Plan – Appendix L*, identifies key features of the three hydroelectric complexes located in California that are part of the Proposed Project in reference to the National Register of Historic Places eligibility recommendations.

Upper Klamath River Stateline Archaeological District

The newly designated Upper Klamath River Stateline Archaeological District (BLM 2016) is located along the Klamath River, in California, less than 0.5-miles from the Oregon-California state line. The district encompasses three pre-contact village sites that contribute to the district’s significance and one lithic scatter that does not contribute. Archaeological research indicates site use in the district extended from circa 1,000 years ago or earlier to possibly as late as the 1840s (BLM 2016). The district was determined eligible for the National Register of Historic Places at the local level of significance under Criterion D in the areas of Prehistoric Archaeology, Native American Ethnic Heritage, Commerce, Economics, Religion, and Politics/Government. The California State Historic Preservation Officer and the Keeper of the National Register of Historic Places have concurred with the district’s eligibility, and it would therefore qualify as an Historical Resource for the purposes of CEQA.

Ethnographic Information and Tribal Cultural Resources

The ethnographic information presented here for the California portion of the Lower Klamath Project identified tribal cultural resources, and other culturally sensitive areas along the Klamath River in the Proposed Project area are based on ethnographic inventory reports prepared by the Klamath Tribes (Deur 2004), Shasta Nation (Daniels 2003, 2006), Karuk Tribe (Salter 2003), and Yurok Tribe (Sloan 2003) for the FERC Relicensing study, the 2012 KHSA EIS/EIR, and during AB 52 consultation meetings between the State Water Board the Shasta Indian Nation and the Shasta Nation (Confidential Appendices P and Q).

The Klamath Tribes identified several culturally important locations in the Klamath Basin, and noted that tribal fisheries were impacted as a result of impediment of anadromous fish passage due to Klamath River dams (Deur 2004). The Klamath Tribes also identified places along the Klamath River between J.C. Boyle Dam (Oregon) and the Scott River (California) that have tribal cultural value (Theodoratus et al. 1990).

The Shasta Nation reports (Daniels 2003, 2006) present a list of village sites recorded in ethnographic literature, a list of locations that the Shasta consider traditional cultural properties, and another inventory of 11 locations, drawn from the first two listings, that are eligible for the National Register of Historic Places.

The Karuk (Salter 2003) and Yurok (Sloan 2003) ethnographic reports draw upon oral interviews, other writings, ethnographical literature, and a review of natural and cultural resources within the Klamath River to discuss each tribe's traditional and historical relationships with the river, and its resources, to subsistence, spiritual culture, and identity. These tribes recognized the entire Klamath River as part of an important cultural (ethnographic) riverscape.

Klamath Cultural Riverscape

The Klamath River Inter-Tribal Fish and Water Commission incorporated information from existing ethnographic studies, in addition to information provided by the Hoopa Valley Tribe, into a report that focused on the Klamath River (King 2004). The entire length of the river was then identified as a type of cultural or ethnographic landscape, termed the Klamath Riverscape, due to the relationship between The Klamath Tribes, Shasta, Karuk, Hoopa, and Yurok tribes and the river and its resources (Gates 2003, King 2004). The characteristics that contribute to the riverscape's cultural character include natural and cultural elements such as the river itself; its anadromous and resident fisheries; its biological diversity; and its cultural sites, sacred places, uses, and perceptions of value by the tribes (King 2004). Gates (2003) and King (2004) recommend the Klamath Riverscape as eligible for the National Register of Historic Places based on its association with broad patterns of tribal environmental stewardship, spiritual life, and relationships between humans and the non-human world. The ethnographic reports for the riverscape and its eligibility determination have not been submitted to the Oregon and California State Historic Preservation Officers for national or state register for concurrence (USBR and CDFG 2012). This EIR recognizes the Klamath Cultural Riverscape as a Tribal Cultural Resource under Public Resources Code, section 21074.

The Klamath Riverscape's contributing elements include the resources described in the 2012 KHSA EIS/EIR's discussion of tribal trust resources and resources traditionally used by tribes (see Appendix V – 2012 KHSA EIS/EIR *Section 3.12 Tribal Trust*). It is clear from formal consultation under AB 52 with the Yurok Tribe that the health of the Klamath River as a whole, as well as the fishery in particular, are of critical importance to the Tribe's well-being and identity, forming a core for cultural, spiritual, and economic life, and that the Klamath River as a whole constitutes a vital Tribal Cultural Resource. Formal and informal consultation, and comments from tribal representatives from the Karuk Tribe, Hoopa Valley Tribe, and the Klamath Tribe, also underscore the high degree to which the Klamath River's water quality and fisheries are important cultural resources.

Historical Landscape Analysis

As part of the Project Area records search, a historical landscape analysis was conducted to identify locations where post 1850s era settlement and resource developments occurred within the records search area (AECOM 2018). The sources for this study included the review of the General Land Office records, including California plat maps (1856, 1876, 1880, and 1881) and surveyor's notes; a variety of published and manuscript resources (Beckham 2006, Boyle 1976, Kramer 2003a, PacifiCorp 2004, USDI 1989); and USGS maps available at http://historicalmaps.arcgis.com/usgs. Other map searches included the David Rumsey collection, Northwestern California map collection at Humboldt State University, Library of Congress digital collections, and Online Archive of California. Historical landscape information was digitized into a GIS format and a table prepared with site-specific information annotated by Township/Range/Section (Appendix B: *Definite Plan – Appendix L,* Table 6-12). In summary, this research indicated roads, railroads, bridges, logging features, ditches, fence lines, buildings, homesteads, ranches, sites associated with military encampments, and several townsites.

KRRC is currently completing the review of the J.C. Boyle Collection (MI 165306) housed at the Southern Oregon Historical Society in Medford, Oregon. This archive contains photo albums, newspaper clippings, maps, manuscripts, financial records, and Copco annual reports belonging to Copco Engineer J.C. Boyle, and pertaining predominately to construction of Copco No. 1 Dam and Reservoir. This archive is a valuable source of information concerning the pre-inundation historical landscape of the Copco No. 1 area and provides important information regarding cultural and historical resources that may be encountered during reservoir drawdown. In addition, archival and historical landscape research is currently underway at local County repositories and historical societies to provide information regarding cultural and historical resources that may be anticipated during reservoir drawdown at J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate reservoirs.

3.12.3 Significance Criteria

Criteria for determining significance of impacts on historical and tribal cultural resources are based upon consultation, referenced texts, the Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.), and professional judgment.

Impacts to historical and tribal cultural resources are significant if they include the following:

- Physical demolition, destruction, relocation, or other alteration of the historical or tribal cultural resource or its immediate surroundings such that the significance of the historical or tribal cultural resource would be materially impaired.
- Exposure or substantial movement of human remains or associated funerary items[143].
- Exposure of, substantial movement of or increased access to other historic tribal cultural resources leading to increased access and looting[144] of tribal cultural resources above levels occurring under existing conditions.
- Elimination or substantial restriction[145] of access of tribal members to their respective tribal cultural resources above levels occurring under existing conditions.

Tribal cultural resources are defined in Public Resources Code Section 21074 as either a site, feature, place or cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to the affected tribe, and that is:

1. Listed or eligible for listing in the national or California Register of Historical Resources, or in a local register of historical resources, or
2. A resource that the lead agency determines is a tribal cultural resource, as further described below.

A lead agency has discretion in identifying unlisted resources as tribal cultural resources, but such a determination requires substantial evidence under the criteria used to determine listings in the historical register and considering the significance of the resource to a California Native American tribe (Public Resource Code, Sections 5024.1, 21074). California Native American tribes traditionally and culturally affiliated with the geographic area of a project may have expertise concerning their tribal cultural resources (Public Resource Code, Section 21080.3.1).

3.12.4 Impact Analysis Approach

The historical and tribal cultural resources impact analysis is based on a review of existing information, such as the results of the California Historical Resources Information System confidential record searches, KRRCs identification efforts (Appendix B: *Definite Plan – Appendix L*) and the AB 52 process with Native American tribes and representatives. Additionally, information received during public scoping was also used to identify potentially important cultural resources (Appendix A).

Known tribal cultural resources within the Proposed Project Area of Analysis include archaeological sites and districts, ethnographic villages, historic period Shasta communities, cemeteries, and cultural landscapes associated with the historical uses of the environments surrounding Iron Gate and Copco No. 1 reservoirs.

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[143] Substantial movement is defined as movement that would displace tribal cultural resources completely or predominantly outside of existing cultural context in a manner that would impair its cultural significance.
[144] Refers to the illicit collection of artifacts or other tribal cultural resources.
[145] Substantial restriction is defined as loss of access during ceremonial windows or periods of hunting and gathering or other traditional activities associated with a particular tribal cultural resource.

Parts of AB 52 (Gatto 2014) amended Public Resources Code to require consultation with California Native American tribes, when requested, and consideration of tribal cultural resources in the CEQA environmental review process. Following the public scoping meetings, the State Water Board conducted a series of confidential consultation meetings with the Shasta Indian Nation, Yurok Tribe, and Shasta Nation. During consultation, the State Water Board sought information regarding the identification of areas with religious or cultural importance to these tribes, potential impacts of the Proposed Project on such resources, and mitigation measures to avoid, minimize or mitigate adverse effects to identified resources. Information discussed as part of AB52 consultation is incorporated into the impact analyses for historical and tribal cultural resources, as appropriate. AB 52 consultation resulted in development of, and agreement on, mitigation measures with the Shasta Indian Nation and the Yurok Tribe. Consultation with the Shasta Nation informed development of mitigation measures, but the AB 52 process concluded without agreed-upon mitigation measures.

The impact analysis approach for historical and tribal cultural resources also considered existing studies related to reservoir inundation and drawdown with respect to resources located within the Iron Gate and Copco No. 1 reservoir footprints, as described below.

3.12.4.1 Studies on Effects of Reservoir Inundation on Cultural Resources

Lenihan et al. (1981), conducted an interagency, interdisciplinary study on the effects of freshwater reservoirs on cultural resources in order to address conservation management of inundated resources. A hierarchical scheme composed of three levels of cultural resources was assessed for inundation effects: artifacts and artifact assemblages; archaeological site or loci; and regional environmental data base, settlement and resource utilization patterns. The use of the hierarchical scheme was intended to include cultural values beyond discrete sites or artifacts that include spatial, temporal, and organizational relationships between the entities within an environmental and cultural context.

This approach is particularly applicable to landscape level resources such as traditional cultural properties and ethnographic landscapes, even though these property type names came into use after the Lenihan et al. (1981) study. When a river with a long history of cultural use is dammed and water is impounded, the cultural landscape is adversely affected through direct impacts to the archaeological or historical sites themselves and to the relationships of these properties to their environment and to each other on local and broader scales. Besides the changes to the environmental setting, processes of inundation that could affect cultural resources are sediment transport and deposition, erosion processes of wave action along shorelines, and saturation and slumping of submerged strata (Lenihan et al. 1981). Note that slumping, or short-term hillslope instabilities, as may occur during reservoir drawdown are discussed in Section 3.11 *Soils, Geology, and Mineral Resources*, Potential Impact 3.11-3, as well as below for tribal cultural resources (Potential Impact 3.12-2) and historical resources (Potential Impact 3.12-13). Erosion of sediment stored within the Lower Klamath Project reservoirs during reservoir drawdown and the potential for downstream sedimentation due to the released sediment is discussed in Section 3.11 *Soils, Geology, and Mineral Resources*, Potential Impact 3.11-5.

Four factors regarding the extent of impacts to archaeological sites by these processes include the characteristics of the reservoirs themselves (size and operation-fill rate and drawdown frequency); location of sites within the impoundment; geological foundation of a site; and characteristics of the site itself (Lenihan et al. 1981). Erosion processes are most damaging along the edges of the reservoirs in wave action zones that vary vertically with reservoir operations. In general, cultural resource sites located within the wave action zone are most heavily affected, while inundated sites beyond the shore are less affected by erosion and may be capped with sediment. A multitude of other factors, such as, slope, vegetation coverage, substrate, soil and water chemistry, also influences the extent of the impacts to a cultural resource site from inundation. Surface artifact displacement from water movement results in an overrepresentation of heavier weight artifacts (such as, groundstone) and an underrepresentation of lighter weight artifacts (such as, lithic flakes). Damage from vandalism, both intentional and unintentional, increases to sites exposed through erosion and reservoir fluctuations. All of these impacts limit the ability to reconstruct human behavior through artefactual, paleoenvironmental, and site analyses; through direct dating techniques and relative dating of vertical and horizontal placement; and through contextual relationships.

Surveys for previously inundated ancestral Puebloan archaeological sites being exposed due to lowering lake levels as a result of drought at Lake Mead, the reservoir behind Hoover Dam, in Southern Nevada resulted in situations where inundation preserved the sites (Haynes 2008). Sites in shoreline locations were eroded as water regressed, resulting in extensive damage to architectural remains and in the removal of the surface artifact assemblages. In lower energy situations, inundation resulted in capping of the sites with sediment that enhanced preservation. Both architectural and non-architectural features and surface artifacts remained. In other situations, effects of inundation and drawdown resulted in differential artifact removal and secondary re-deposition. Factors contributing to impacts from inundation and later exposure include: energy levels of the reservoir at the site location; terrains upon which the sites sit; weight of artifacts; and artifact collecting once sites were exposed. The results of these surveys on lands exposed from natural drawdown at Lake Mead, a man-made reservoir, are directly applicable to the proposed drawdown of the reservoirs along the Klamath River.

3.12.5 Potential Impacts and Mitigation

3.12.5.1 Potential Impacts to Tribal Cultural Resources

For the purposes of the mitigation measures TCR-1 through TCR-7, the following definitions apply:

Affected Tribes: Tribes on the Native American Heritage Commission list that (1) have expressed interest in participating in further development of the Tribal Cultural Resources (TCRs) measures for the Lower Klamath Project (Project) within 60 days of the Klamath River Renewal Corporation’s (KRRC) January 8, 2018, notice and (2) are traditionally and culturally affiliated with the Area of Potential Effect or otherwise affected by the Project. As of August 13, 2018, the following Native American tribes have expressed interest in participating in further development of such mitigation measures: Cher-Ae heights Indian Community of the Trinidad Rancheria, Karuk Tribe, Klamath Tribes, Modoc Tribe of Oklahoma, Quartz Valley Indian Reservation, Shasta Indian Nation, Shasta Nation, and the Yurok Tribe.

Consultation: Consultation with Affected Tribes in a manner consistent with applicable law. KRRC intends to implement these requirements consistent with California Environmental Protection Agency's "Policy on Consultation with California Native American Tribes," CIT-15-01 (August 20, 2015).

Project Implementation: Project implementation is defined as pre-construction activities, reservoir drawdown, dam removal, restoration activities, and other ground-disturbing activities that comprise the Project, as stated in the Definite Plan.

Potential Impact 3.12-1 Pre-dam-removal activities that involve disturbance of the landscape, including construction or improvement of associated roads, bridges, water supply lines, staging areas, disposal sites, hatchery modifications, recreation site removal and/or development, and culvert construction and improvements could result in potential exposure of or damage to known Tribal Cultural Resources through ground-disturbing construction and disposal activity and increased access to sensitive areas.

Pre-dam removal activities involving ground disturbance, construction or improvement of associated roads, bridges, water supply lines, staging areas, disposal sites, hatchery modifications, recreation site removal and/or development, and culvert construction and/or improvements would occur within the Area of Analysis *Subarea 1* (Figure 3.12-2).

Tribal cultural resources are known to be present within Area of Analysis *Subarea 1* (Figure 3.12-2). Cultural resource sites identified at the edges of Copco No. 1 Reservoir include prehistoric archaeological sites with habitation debris and several contributing elements of the ethnographic landscape (Cardno Entrix 2012, Daniels 2006, Heizer and Hester 1970, PacifiCorp 2004). In addition, ethnographic village sites have been identified within Copco No. 1 Reservoir (Heizer and Hester 1970, Daniels 2006). Native American burials and traditional use areas (for ceremonies) within the Copco No. 1 Reservoir footprint have also been identified through ethnographic research and consultations with the Shasta people. At least one ethnographic village site has been identified within Iron Gate Reservoir by PacifiCorp (2004) and Daniels (2006). Specific TCR locations known to the Shasta people, which include TCRs as reflected in PacifiCorp (2004) and Daniels (2006), and as updated by Confidential Appendix Q, Attachment 4, are cataloged in Confidential Appendices P and Q. Resources identified as villages, cairns or burial sites, or sites eligible for the National Register of Historic Places (NRHP) in a subsequent compilation by Cardno ENTRIX (2012) were also considered as part of this analysis.

Due to the nature of ground-disturbing activities and a general increase in the level of activity (e.g., construction, surveys) within the Area of Analysis *Subarea 1*, pre-dam removal activities that would involve ground disturbance have the potential to result in the following significant impacts to known TCRs identified in Confidential Appendices P and Q, as well as unknown TCRs:

- Physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of the TCR would be materially impaired; and/or
- Exposure or substantial movement of TCRs leading to increased access and looting above levels occurring under existing conditions.

Note that TCR sites located within the reservoir fluctuation zones (Confidential Appendices P and Q) may be periodically at risk of looting during low water periods under existing conditions and may have suffered significant degradation in the existing condition.

Implementation of mitigation measures TCR-1 (TCRMP), TCR-2 (LVPP), TCR-3 (IDP), TCR-4 (Endowment)[146] would reduce these impacts considerably, and, for many resources is expected to avoid impacts completely, through the design and implementation of construction plans to completely avoid impacts, or on-the-ground modifications to Proposed Project implementation to avoid impacts. For impacts for which it is not feasible to completely avoid impacts, these impacts may be reduced to a less-than-significant level. The measures (listed fully, below) include among other requirements, field worker training, limits to worker and public access, tribal monitors, surveys, and identification of protocols and best practices upon discovery or disturbance of TCRs during implementation of the Proposed Project. With timely discovery and appropriate steps to address exposure or damage, many TCRs can maintain their current level of cultural significance. Additionally, providing a means for the long-term protection or enhancement of affected TCRs can mitigate for some impacts.

However, the impact of exposing, disturbing or otherwise damaging tribal human remains, or associated funerary items, is itself profound. While the mitigation measures are expected to considerably reduce impacts, they cannot reasonably be expected to eliminate such exposure or disturbance, particularly where, as here, the number of potentially affected burials is high. While treating remains and associated funerary objects with the appropriate respect and procedures can reduce and avoid compounding the harm from the initial damage, it cannot do so fully. Additionally, in light of the high density of TCRs within the Limits of Work, and the nature of the construction involved, significant risk remains that other TCRs may sustain damage that results in a material impairment of the resource's significance. In light of the particular harm of exposing human remains even where they are treated appropriately after exposure, and the likelihood of significantly impairing other types of TCRs in light of the type of construction actions and the density of resources, the impact would remain significant and unavoidable.

Mitigation Measure TCR-1 – Develop and Implement a Tribal Cultural Resources Management Plan.

The KRRC shall develop a Historic Properties Management Plan (HPMP). The HPMP shall include measures to avoid, minimize, or mitigate the Project's adverse impacts to TCRs. The HPMP shall include a Tribal Cultural Resources Management Program (TCRMP), which will state such measures.

KRRC shall develop the TCRMP in consultation with Affected Tribes. The KRRC shall finalize the HPMP during FERC's hearing on the license surrender application for the Project. The KRRC shall propose the HPMP for FERC's approval as a term of the license surrender order.

[146] Mitigation Measures TCR-6, TCR-7, and TCR-8 could also further reduce the potential impact. However, at this point it is not clear whether the measures are feasible (see Potential Impact 3.12-9.) Therefore, this EIR does not rely on implementation of these measures, in reaching its significance determinations.

In developing the TCRMP, KRRC shall engage in good faith consultation with the Affected Tribes that are traditionally and culturally affiliated with a specific portion of the APE or with potentially affected TCRs. Where a particular tribe has identified a specific TCR, the primary consultation about that TCR shall be with the affected tribe. All such consultation shall be subject to the schedule for HPMP development. If consensus cannot be reached during TCRMP development, KRRC shall record the disputed issues, positions on the disputed issues, and KRRC's proposed resolution, in the HPMP that is submitted to FERC.

The TCRMP shall include the following elements consistent with applicable law:

1. The TCRMP shall include an inventory of known and potential TCRs that could be affected by the Project. Appendix B: *Definite Plan – Appendix L* includes a preliminary inventory of such resources. KRRC will continue to develop the inventory through the consultation process for the license surrender application under authority of the National Historic Preservation Act (NHPA) Section 106.

   Based on AB 52 consultation, KRRC acknowledges that the Shasta Indian Nation and Shasta Nation are primarily concerned with TCRs associated with Iron Gate, Copco No. 1, and Copco No. 2 reservoirs, and tributary sub-watersheds such as Fall Creek, Bogus Creek, and Deer Creek. The TCRMP shall include TCRs known to the Shasta Indian Nation, which include TCRs as reflected in PacifiCorp (2004) and Daniels (2006) and as updated by Attachment 4 of the Confidential Appendix Q. The TCRMP shall include TCRs known to the Shasta Nation, which include the TCRs identified in the Confidential Appendix P. The TCRMP shall include TCRs known to other Affected Tribes.
2. The TCRMP shall include provisions to protect the confidentiality of known TCRs. The TCRMP shall also include provisions to share information collected by the KRRC with: Affected Tribes that are traditionally and culturally affiliated with the known TCR(s); regulatory agencies that have authority over protecting such resources, as necessary; or as necessary with the permission of such tribes in order to implement appropriate protective or enhancement measures. These provisions will be consistent with California Public Resources Code Section 21082.3(c).
3. The TCRMP shall assure that the Project will avoid, minimize, or mitigate adverse impacts to TCRs, consistent with California Public Resources Code section 21084.3(a). In developing the plan, the KRRC will consider measures listed in California Public Resources Code section 21084.3(b) that, if feasible, may be appropriate to avoid, minimize, or mitigate adverse impacts:

   (1) "Avoidance and preservation of the resources in place, including, but not limited to, planning and construction to avoid the resources and protect the cultural and natural context, or planning greenspace, parks, or other open space, to incorporate the resources with culturally appropriate protection and management criteria.

   (2) Treating the resource with culturally appropriate dignity taking into account the tribal cultural values and meaning of the resource, including, but not limited to, the following:

   (A) Protecting the cultural character and integrity of the resource.

   (B) Protecting the traditional use of the resource.

   (C) Protecting the confidentiality of the resource.

(3) Permanent conservation easements or other interests in real property, with culturally appropriate management criteria for the purposes of preserving or utilizing the resources or places in a manner consistent with the KHSA.

(4) Protecting the resource."

4. The TCRMP shall require a training program for KRRC's field personnel associated with the Project. The training program will be designed to train KRRC field personnel to work collaboratively with tribal monitors and will focus on field procedures (across the range of field personnel) as necessary for appropriate and respectful treatment of TCRs; and will be intensive and systematic, in light of the scale, complexity, and schedule of the Project undertakings.
5. The TCRMP shall identify TCR areas that will have limited or no public access during Project implementation. During that period, the KRRC shall: install adequate signage to clearly mark areas with limited or no public access areas; install fencing where necessary and feasible to reduce access; and provide appropriate training to field personnel. Upon the recommendation of a tribe that has identified the TCR area, the KRRC may consider, and the TCRMP may include, other equally effective measures to reduce public access in lieu of (or in addition to) those identified immediately above.
6. The TCRMP shall include site-specific mitigation measures for potentially affected TCRs. The TCRMP shall provide for ongoing consultation or site-specific mitigation refinement with the relevant Affected Tribe(s) with a traditional and cultural affiliation to an impacted TCRs, as appropriate and feasible consistent with the schedule for Project implementation.
7. The TCRMP shall identify any areas where the KRRC, before Project implementation, shall conduct any additional cultural resource surveys, consistent with California Public Resources Code section 21074.
8. The TCRMP shall provide that the KRRC, following reservoir drawdown and dam removal, shall undertake intensive surveys of TCRs, archaeological, and other historical resources within the area of analysis, using joint teams of archaeologists and tribal monitors. The TCRMP shall specify the methods for such surveys. It shall also specify the process by which Affected Tribes will nominate, and KRRC will select and compensate tribal monitors. During this process, an Affected Tribe that is traditionally and culturally affiliated with the area may nominate tribal monitor(s) for KRRC's consideration; and KRRC shall make the selection after consultation with Affected Tribes. KRRC shall select and pay tribal monitor(s) for the purpose of Project implementation. In the event that KRRC does not select a tribe's recommended monitor, an Affected Tribe that is traditionally and culturally affiliated with the area may request participation of its recommended tribal monitor in these surveys at its own cost. KRRC's field personnel, in consultation with tribal monitors, shall record these surveys in a manner consistent with applicable law. KRRC shall provide recorded survey data pertaining to a known TCR to the Affected Tribes that are traditionally and culturally affiliated with that TCR.
9. The TCRMP shall state a range of appropriate measures, and a protocol to select from such range, to address the disturbance or exposure of known TCRs during Project implementation. The KRRC shall implement measures necessary to ensure the protection of disturbed or exposed TCRs.
10. The TCRMP shall provide that the KRRC will identify and avoid TCRs during the siting and construction of new recreational sites, to the extent feasible. The

KRRC shall address potential conflicts consistent with California Public Resources Code section 21084.3(a) and (b).

11. The TCRMP shall provide for restoration actions associated with any ground disturbances such as grading and manual or machine excavation, so as to protect TCRs. The KRRC shall consider limiting or completely avoiding mechanical weed control activities (e.g., mowing, hand-weeding) or herbicide use to protect TCRs in areas identified by Affected Tribes, as necessary. In revegetation efforts, the KRRC shall incorporate specific plant species that are important to Affected Tribes with a traditional and cultural affiliation to the area at issue, to the extent that doing so is feasible and complies with the requirements of the federal and state approvals of the Project. The KRRC shall provide training regarding these actions to its field personnel.
12. The TCRMP shall incorporate the results of the KRRC's Bathymetric Survey, and specifically, the refined understanding of sediment thickness in Iron Gate and Copco No. 1 reservoirs, to inform monitoring efforts for potential exposure of TCRs during and following reservoir drawdown. Information from this review shall inform the Inadvertent Discovery Program (described below), which will be part of the TCRMP.
13. The KRRC shall consult with Affected Tribes in the planning process for the redesign and relocation of the water supply line for the City of Yreka to identify, avoid if feasible, or mitigate effects to TCRs during the siting and construction of the water supply line. The KRRC shall address potential conflicts consistent with California Public Resources Code section 21084.3 (a) and (b).
14. Consistent with KHSA Section 7.6.6, the TCRMP shall include recommended measures to identify, avoid, minimize, or mitigate effects to TCRs during modifications of Iron Gate Hatchery, consistent with California Public Resources Code section 21084.3 (a) and (b).
15. Consistent with KHSA Section 7.6.6, the TCRMP shall also include recommended measures to identify, avoid, minimize, or mitigate adverse impacts to TCRs during rehabilitation and expansion of Fall Creek Hatchery, consistent with California Public Resources Code section 21084.3 (a) and (b).
16. The TCRMP shall include a dispute resolution process in the event that, during Project implementation, Affected Tribes dispute which measures to apply to avoid, minimize, or mitigate the Project's adverse impacts to a specific TCR with which the Affected Tribes are traditionally and culturally affiliated. The process shall include neutral mediation to be undertaken consistent with the schedule for Project implementation. In consultation with Affected Tribes, the KRRC shall engage a standing mediator who is available to resolve disputes about which measures to apply.

Mitigation Measure TCR-2 – Develop and Implement a Looting and Vandalism Prevention Program.

In consultation with Affected Tribes and jurisdictional law enforcement, the KRRC shall develop and implement a Looting and Vandalism Prevention Program (LVPP), specifically to deter looting and vandalism to TCRs associated with the Project. The LVPP, which may be part of the TCRMP, shall include the following elements consistent with applicable law:

1. The LVPP shall include appropriate measures to deter looting and vandalism during Project Implementation. The KRRC shall implement these measures for a

minimum of 3 years following completion of dam removal, or until KRRC has transferred applicable Parcel B lands to the States or third parties under the terms of the KHSA Section 7.6.4.

2. The LVPP shall specify the frequency of monitoring efforts of known TCR areas and other areas subsequently identified by the KRRC or tribal monitors during Project implementation. Monitoring frequency shall not be less than quarterly, with allowances for additional targeted monitoring that is triggered by natural or opportunistic events, such as a large magnitude flood event. The LVPP shall provide that monitoring need and frequency will vary depending on the level of risk associated with various activities during Project implementation.
3. The LVPP shall include a training program on looting and vandalism prevention and site documentation, for the benefit of KRRC's field personnel as well as tribal monitors.
4. The LVPP shall include protocols for communications and reporting to law enforcement and other relevant state and federal agencies, consistent with applicable law.
5. The LVPP shall include appropriate measures to restrict public access to specific Project areas where known TCRs, or those identified through inadvertent discovery, are located. KRRC shall implement these measures until it has transferred the Parcel B lands to the states or third parties under KHSA Section 7.6.4. Specific measures to be considered shall include: fencing; posting of signs; strategic plantings; strategic routing of access roads, boating access points and trails; specific recommendations for land use or land transfer in the KHSA Section 7.6.4 process or other means determined necessary and feasible to protect TCRs from opportunistic looting and public access (authorized and unauthorized).
6. The LVPP shall include appropriate measures to prevent or restrict public access to reservoir areas during reservoir drawdown and dam removal.
7. The LVPP shall include appropriate measures to prevent or restrict public access to newly exposed reservoir areas following reservoir drawdown. Such measures shall limit use of off-road vehicle paths and informal roads and tracks, and unauthorized use of developed and dispersed recreation sites. KRRC shall implement these measures until it transfers Parcel B lands to the states or third parties pursuant to KHSA Section 7.6.4, subject to an assignment of continuing responsibilities by the transferee.

Mitigation Measure TCR-3 – Develop and Implement Inadvertent Discovery Plan (IDP).

In consultation with Affected Tribes, the KRRC shall develop and implement an Inadvertent Discovery Program (IDP), which shall be a part of the TCRMP. The IDP shall establish protocols for the discovery of unanticipated or previously unknown TCRs, including human burials or human remains discovered during Project implementation. The IDP shall provide for compliance with applicable law regarding cultural resources and human remains; state work site protocols to be followed in the event of an inadvertent discovery; and identify appropriate point of contacts associated with the protocols. The IDP shall include protocols for work in areas known to have a high chance of inadvertent discoveries, including the Iron Gate, Copco No. 1, Copco No. 2 reservoir areas, as well as the altered FEMA 100-year floodplain area between Iron Gate Dam and Humbug Creek following dam decommissioning.

The IDP shall include the following specific elements:

1. The IDP shall acknowledge that there may be unknown TCRs in association with TCRs known to the Shasta Indian Nation, which include TCRs as reflected in PacifiCorp (2004) and Daniels (2006) and as updated by Confidential Attachment 4 of the Confidential Appendix Q.
2. The IDP shall state protocols that KRRC shall implement for sites that are addressed under California Public Resources Code 5097.993 and/or for sites found to contain TCRs, human burials, or human remains during and after drawdown activities. These protocols shall identify appropriate agency and tribal contacts for such situations. In the case of human remains in California, the KRRC shall also notify the county coroner and follow the procedures stated in California Health and Safety Code section 7050.5(b) to the extent feasible. Upon discovery, the KRRC's environmental monitor shall notify the KRRC's qualified archaeologist of the discovery, and the KRRC's qualified archaeologist shall complete a letter report to assess and document the discovery. The KRRC shall circulate the letter report to Affected Tribes, the Native American Heritage Commission for inadvertent discoveries on private and state lands in California, and other appropriate land management agencies, within 72 hours of the discovery.
3. The IDP shall state protocols that KRRC will implement for reservoir drawdown or restoration activities following an inadvertent discovery. Such protocols shall be consistent with the Definite Plan and shall take into account potential downstream environmental impacts; cultural resource impacts in the Iron Gate, Copco No. 1, Copco No. 2 reservoir areas; mitigation and stabilization for tribal and cultural resources found in the APE outside of the reservoirs; and mitigation in the altered FEMA 100-year floodplain area between Iron Gate Dam and Humbug Creek following dam decommissioning. The IDP shall identify the measures that the KRRC will follow to protect TCRs following an inadvertent discovery.
4. The IDP shall provide for tribal monitors to participate in monitoring during Project implementation. The tribal monitors shall be present as feasible and appropriate pursuant to the schedule for different phases of Project implementation, to address unknown TCRs that are exposed. Pursuant to item (6), the monitoring schedule for tribal monitors shall consider that monitoring frequency and duration may differ by geographic area or Project phase or activity.
5. The IDP shall provide for the development and implementation of a training program regarding the inadvertent discovery of cultural resources and human remains during Project activities. All of KRRC's field personnel and tribal monitors shall be instructed on site discovery, avoidance, and protection measures, including information on the statutes protecting cultural resources.
6. The IDP shall establish the frequency of specific monitoring efforts during Project implementation in identified areas where the discovery of unidentified TCRs may be likely given currently available information and other known archaeologically or culturally sensitive areas that may be identified by the tribal monitors. Monitoring locations will be specified during the development of the Inadvertent Discovery Program in the HPMP. Monitoring frequency during Project activities that cause ground disturbance shall not be less than quarterly, with allowances for additional targeted monitoring that is triggered by natural or opportunistic events during the reservoir drawdown or a subsequent large magnitude flood event. Such monitoring efforts shall be led by KRRC's archaeologists in consultation with tribal

monitors and shall include the field reconnaissance of newly exposed sediments for surface features, to include, but not be limited to intensive, pedestrian survey for areas with relatively low slopes (<30 percent) and that are sufficiently dried to permit for safe access for pedestrian survey and to permit safe access for survey vehicles. In areas where intensive, pedestrian survey is not possible, KRRC in consultation with tribal monitors may use low-elevation aerial survey methods (e.g., unmanned aerial vehicles) or barge surveys to accomplish monitoring.

7. The IDP shall include a timeline, in consultation with Affected Tribes, for completing treatment measures and assessing California Register significance for discovered cultural resources and human burials or remains.
8. The IDP shall include dispute resolution procedures in the event that Affected Tribes disagree on which measures to apply to protect TCRs following inadvertent discovery. When the inadvertent discovery occurs on private or state lands in California, the procedures set forth in California Public Resources Code section 5097.98 will be followed where feasible, including mediation pursuant to California Public Resources Code section 5097.94. To the extent that inadvertent discoveries occur on federal or tribal lands, appropriate procedures under tribal or federal law will apply.

Mitigation Measure TCR-4 – Endowment for Post-Project Implementation.
The TCRMP shall include a provision for the KRRC to provide funding for an endowment or other appropriate organization (e.g., a non-profit mutual benefit organization) to protect and enhance TCRs that are exposed due to the Project implementation on state and private lands in California, on a long-term basis following license surrender. This endowment shall include funding for monitoring, including supplementing or enhancing law enforcement resources, and shall also be available to cover measures that will be implemented following license surrender, including measures related to looting and vandalism protections. The endowment shall be governed in a manner that is representative of Affected Tribes that are traditionally and culturally affiliated with the TCRs impacted by Project Implementation. The KRRC shall consult with Affected Tribes, with the assistance of the standing mediator during development of the TCRMP, to develop the specifications for funding and governance.

Significance

Significant and unavoidable with mitigation

Potential Impact 3.12-2 Drawdown of Iron Gate, Copco No. 1, and Copco No. 2 reservoirs could result in shifting, erosion, and exposure of known or unknown, previously submerged Tribal Cultural Resources.
The Proposed Project would draw down Iron Gate, Copco No.1, Copco No. 2 and J.C. Boyle reservoirs at a rate between 2 and 5 feet per day (i.e., 1 to 2.5 inches per hour). Drawdown of Copco No. 1 would begin November 1 of dam removal year 1 at a maximum rate of 2 feet per day, and drawdown of all reservoirs would occur at a maximum rate of 5 feet per day beginning January 1 of dam removal year 2 and continue until March 15 of the same year. The analysis for Potential Impact 3.12-2 focuses on the California Lower Klamath Project reservoirs, including Copco No.1, Copco No. 2, and Iron Gate, which are contained within Area of Analysis *Subarea 1* (Figure 3.12-2).

Since the Lower Klamath Project reservoirs were constructed, fine sediments composed primarily of organic material (including dead algae), but also including some silts and clays, have accumulated along the reservoir bottoms. The distribution of sediment deposits varies within each reservoir (Figure 2.7-8 and 2.7-9). Because the accumulated sediments are primarily fine material, they would be easily eroded and flushed out of the reservoirs into the Klamath River during reservoir drawdown. The degree of sediment erosion would vary, with the majority of the erosion focused in the historical river channel that is currently submerged in Copco No. 1 and Iron Gate reservoirs (see Figures 2.7-5 and 2.7-6).

Following drawdown, 40 to 60 percent of the existing sediment deposits would remain in place in each of the former reservoir beds, primarily on terraces located above the historical river channel. The sediments that remain in the reservoir footprints would consolidate (dry out and decrease in thickness) (USBR 2012a), making them less subject to erosion. Further, during the drawdown period, aerial seeding of pioneer mixes would occur as the reservoir water level drops before the exposed reservoir sediments dry and form a surface crust. Pioneer seed mixes would contain a variety of riparian and upland common native species, and possibly a small amount of sterile non-native species to enhance initial erosion protection. Aerial seeding during reservoir drawdown would not result in any further disturbance of soil on the exposed reservoir terraces and the establishment of vegetation on the terraces would potentially reduce erosion of fine sediments. Recent laboratory tests of reservoir sediments showed vegetated sediments produced less erodible fine particles and aggregates during cycles of wetting and drying than unvegetated sediments (Appendix B: *Definite Plan – Appendix H*).

Although not currently anticipated by KRRC, the Proposed Project may also include hydroseeding from a barge on exposed reservoir terraces as the water recedes during reservoir drawdown. Hydroseeding from a barge would be accomplished by placing a ground rig on one barge with another boat used to ferry materials from shore. A moveable pier or other engineered method of accessing the supply boat as the water level recedes would also be needed. If it occurs, barge hydroseeding would occur in the higher elevation portion of the reservoir shoreline, until the reservoir levels become too low to operate (i.e., March of dam removal year 2).

The Proposed Project also includes barge-mounted pressure spraying during reservoir drawdown that would target six locations in Copco No. 1 Reservoir and three locations in Iron Gate Reservoir within which to maximize erosion of sediment deposits and subsequently excavate to the historical floodplain elevation to create wetlands, floodplain areas and off-channel habitat features (see Appendix B: *Definite Plan – Appendix H Figures 5-4 and 5-7*).

Tribal cultural resources are known to be present within Area of Analysis *Subarea 1* (Figure 3.12-2). Cultural resource sites identified at the edges of Copco No. 1 Reservoir include prehistoric archaeological sites with habitation debris and several contributing elements of the ethnographic landscape (Cardno Entrix 2012, Daniels 2006, Heizer and Hester 1970, PacifiCorp 2004). In addition, ethnographic village sites have been identified within Copco No. 1 Reservoir (Heizer and Hester 1970, Daniels 2006). Native American burials and traditional use areas (for ceremonies) within the Copco No. 1 Reservoir footprint have also been identified through ethnographic research and consultations with the Shasta Nation and Shasta Indian Nation. At least one ethnographic village site has been identified within Iron Gate Reservoir by PacifiCorp

(2004) and Daniels (2006). Specific TCR locations known to the Shasta people, which include TCRs as reflected in PacifiCorp (2004) and Daniels (2006), and as updated by Confidential Appendix Q, Attachment 4, are cataloged in Confidential Appendices P and Q. Resources identified as villages, cairns or burial sites, or sites eligible for the National Register of Historic Places in a subsequent compilation by Cardno ENTRIX (2012) were also considered as part of this analysis.

It is unknown whether adverse effects have already occurred to known or unknown, previously submerged TCR sites due to saturation within reservoir sediments and overlying water currents. However, impacts to these sites would likely result from shifting and exposure of reservoir sediment deposits during and after drawdown. Some TCR sites within the reservoir footprints may remain covered in sediment, or capped, resulting in some degree of preservation and protection.

Tribal cultural resource sites located in areas of steep or perched slopes, such as those along the steeper edges in the reservoir fluctuation zones[147], may experience shifting and slumping as a result of the underlying strata not being able to support the weight of overlying saturated soils. This is of particular concern for diatomaceous deposits located along the rim and below the Copco No. 1 Reservoir water level (see also Section 3.11.2.2 *Geomorphology* and Potential Impact 3.11-3). While the Proposed Project maximum drawdown rates (i.e., between 2 and 5 feet per day) are intended to minimize the potential for shifting and slumping of sediment deposits during reservoir drawdown, some sediment movement could still occur and could displace tribal cultural resources located in areas of steep or perched slopes that have relatively less thick sediment deposits. Note that some of the tribal cultural sites located within the reservoir fluctuation zones may be experiencing macro-scale wave-induced erosion impacts as part of existing conditions. Existing damage to exposed tribal cultural resources at some of these sites may be evident as wave cut terraces (beachlines) and other areas of accelerated erosion or scouring, as well as pedestaled and redeposited artifacts within the reservoir fluctuation zones. Given the proposed drawdown rates (2 to 5 feet per day), the reservoir shoreline would move below the normal fluctuation zone for each reservoir within 1 to 3 days of beginning drawdown. As this is a relatively short time frame compared to the continuous wave action that happens in this zone under existing conditions, reservoir drawdown alone is not expected to result in additional erosion-induced destruction or material alteration of the known tribal cultural resource sites in a way that would undermine their current or historical tribal significance relative to existing conditions. If it occurs, barge hydroseeding within the reservoir fluctuation zone would not result in additional wave-induced shoreline erosion outside of the range of existing conditions because barges tend to generate low wave heights due to their wide, flat bottoms and low operating speeds. Further, any concentrated additional wave-induced erosion from barge hydroseeding would be limited to a shorter duration (i.e., over several hours within a single day) than that of wind-action on the slowly downward-moving reservoir surface. Therefore, barge hydroseeding would be unlikely to exacerbate erosion impacts beyond that of reservoir drawdown itself, which would be within the range of existing conditions.

[147] For Copco No. 1 Reservoir, the normal maximum and minimum reservoir operating levels are between 2,607.5 and 2,601.0 feet mean sea level (MSL), respectively, or a range of 6.5 feet for the reservoir fluctuation zone (PacifiCorp 2004b). For Iron Gate Reservoir, levels are between 2,330.0 and 2,324.0 feet MSL, respectively, or a range of 4 feet for the fluctuation zone (PacifiCorp 2004b).

Additional potential impacts to TCR sites within the reservoir footprints, including short-term erosion, surface/shallow subsurface disturbance (i.e., sediment slumping), artifact displacement, and precipitation-induced runoff disturbance are discussed in Potential Impact 3.12-7. Increased potential for looting of exposed TCRs at Iron Gate, Copco No. 1, and Copco No. 2 reservoirs during and following reservoir drawdown activities is discussed in Potential Impact 3.12-6.

Overall, the increased likelihood of impacts to known or as-yet unknown previously submerged TCRs due to drawdown of Iron Gate, Copco No. 1, and Copco No. 2 reservoirs would be a significant impact in light of the following:

- Increased potential for shifting, erosion, and/or exposure of TCRs that results in destruction or material alteration of the resources in a way that would undermine current or historical significance, in light of an existing condition in which the TCRs are under water.
- The large number of known TCRs, and the high potential for the presence of as-yet unknown TCRs, that are currently submerged by Copco No.1, Copco No. 2, and/or Iron Gate reservoirs.

Implementation of Mitigation Measures TCR-1 (TCRMP), TCR-2 (LVPP), TCR-3 (IDP), and TCR-4 (Endowment)[148] would reduce these impacts considerably, and, for many resources is expected to avoid impacts completely or to reduce the impact to less than significant. The measures (listed fully, below) include, among other requirements, timely surveys of exposed land, on-side tribal monitors, limits to public access, and identification of protocols and best practices upon discovery or disturbance of TCRs in project implementation. With timely discovery and appropriate steps to address exposure, shifting or erosion impacts, many TCRs can maintain their current level of cultural significance. Additionally, providing a means for the long-term protection or enhancement of affected TCRs can mitigate for certain impacts.

However, the impact of exposing or disturbing tribal human remains, or associated funerary items, is itself profound. While the mitigation measures are expected to considerably reduce impacts, they cannot reasonably be expected to eliminate such exposure or disturbance, particularly in light of evidence that the number of submerged burial sites is high. Thus, while drawdown is not generally anticipated to have large effects on material below the earth's surface at the time of reservoir inundation, where slumping is a risk and where so many sites are involved (including some sites that have been subject to wave action with an erosive effect) material risk remains that some burials may be affected. While treating remains and associated funerary objects with the appropriate respect and procedures can reduce and avoid compounding the harm from the initial exposure or movement, it cannot do so fully. In light of the particular harm of exposing human remains even where they are treated appropriately after exposure, the impacts would remain significant and unavoidable.

Significance

Significant and unavoidable with mitigation

[148] Mitigation Measures TCR-6, TCR-7 and TCR-8 could also further reduce the potential impact. However, at this point it is not clear whether the measures are feasible (see Potential Impact 3.12-8). Therefore, this EIR does not rely on implementation of these measures in reaching its significance determinations.

Potential Impact 3.12-3 Reservoir drawdown could result in short-term erosion or flood disturbance to tribal cultural resources located along the Klamath River.

Hydroelectric Reach

The Hydroelectric Reach from the California-Oregon state line to Copco No. 1 Reservoir includes prehistoric archaeological riverside sites with habitation debris, house pits and rock features and cemeteries; as well as ethnographic places and other features of the cultural landscape (PacifiCorp 2004, Daniels 2006). Historic period refuse scatters, an historical hotel ruin sites, historical ranching sites, and historic roads are also present (Cardno Entrix 2012). There are known TCR sites located within the Area of Analysis *Subarea 3* (Figure 3.12-4) along the Klamath River between J.C. Boyle Dam and Copco No.1 Reservoir (Confidential Appendices P and Q). Certain of these sites may be impacted by increased flows during drawdown of J.C. Boyle Reservoir in Oregon because they are situated along the river's edge. It is a profound concern of the Shasta Nation that particular TCR sites along this reach would be flooded, and possibly destroyed, during drawdown (see also Confidential Appendix P as well as Shasta Nation consultation letter [2/1/2017] and public scoping letter [2/1/2017]).

As the Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities are located below this section of the Klamath River, the TCRs in this area would only be affected by the drawdown of J.C. Boyle. J.C. Boyle Reservoir has a relatively small storage capacity (3,495 acre-feet) and is not operated by PacifiCorp as a flood control reservoir. PacifiCorp operates J.C. Boyle Reservoir to produce hydroelectric power. Under current operations, when the inflow to J.C. Boyle Reservoir is below approximately 2,800 cfs, water is typically stored at night and released for power generation during the day which coincides with peak energy demand. When the inflow to the reservoir is greater than approximately 2,800 cfs, water does not need to be stored to generate power since the maximum capacity of the two turbine units in the J.C. Boyle Powerhouse is 2,850 cfs and any additional inflow to the reservoir spills over the dam. Spillage over the dam and flow through the J.C. Boyle Bypass reach in excess of the typical 100 cfs bypass flows generally occurs during the months of January through May when the Klamath River inflow to J.C. Boyle Reservoir tends to be greater than 2,800 cfs (Appendix B: *Definite Plan*). All flows diverted for power generation are returned to the Klamath River downstream stream of the J.C. Boyle Powerhouse in the J.C. Boyle Peaking Reach. Flows in the Klamath River between J.C. Boyle Reservoir and the upstream end of Copco No. 1 Reservoir vary by season and year, ranging from a daily mean value of less than 1,000 cfs during summer low flow periods to as high as 10,800 cfs in the spring of 1972 (Figure 3.12-7).

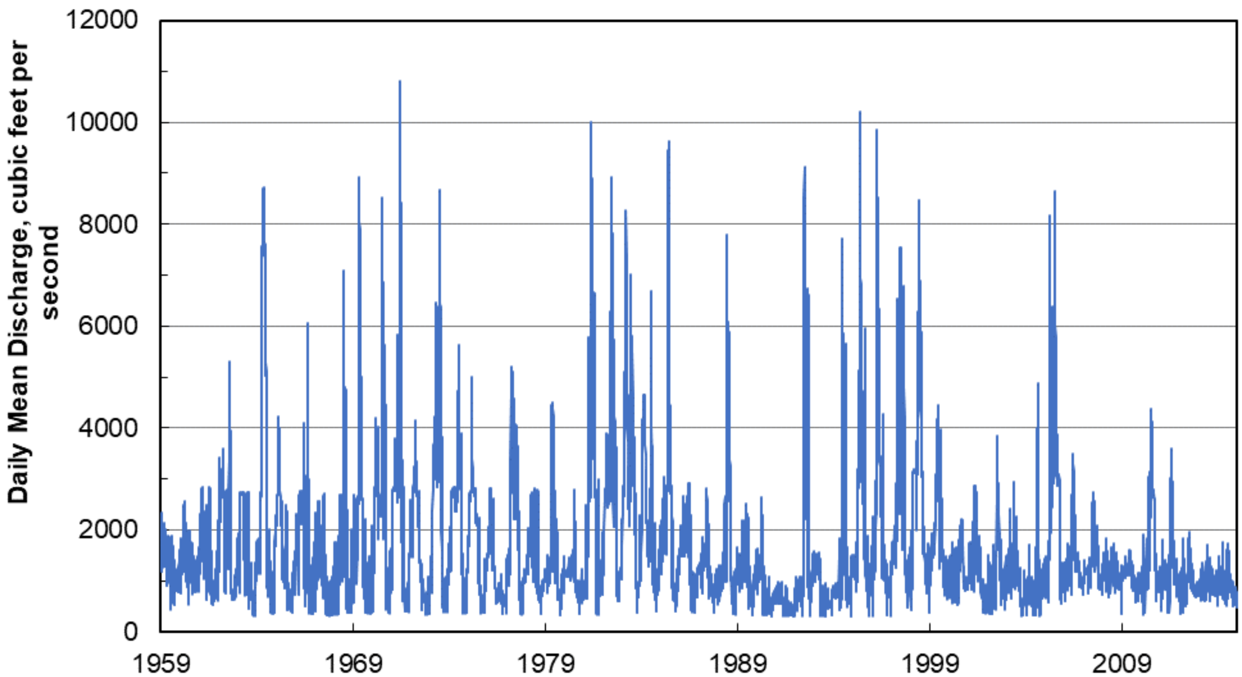

Figure 3.12-7. Discharge (flow) for Klamath River Downstream from J.C. Boyle Powerhouse, 1959–2015. Source: USGS 2016.

The proposed drawdown of the Lower Klamath Project reservoirs is designed to minimize potential flood risks, including carefully drawing down the reservoirs using controlled flow releases and the increased storage availability in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs once drawdown has begun to accommodate for potential winter flow events. Drawdown of J.C. Boyle Reservoir would occur from January 1 to March 15 of dam removal year 2. During drawdown, release flows at J.C. Boyle Dam would range from 1,000 to 3,000 cfs for short durations (1−2 days) (Appendix B: *Definite Plan*). As shown in Figure 3.12-7, flows of this magnitude are typical for the Klamath River upstream of Copco No. 1 Reservoir and downstream from J.C. Boyle Powerhouse and are well below maximum flows (close to 11,000 cfs). Accordingly, the average increase in Klamath River flow due to drawdown of J.C. Boyle Reservoir is expected to be small, from less than 1 percent up to 8 percent during the months of January and February of dam removal year 2 (Appendix B: *Definite Plan*). Thus, the Proposed Project would not result in drawdown flows that are out of the normal range of flows experienced under existing conditions. Since drawdown releases from J.C. Boyle Dam would not cause flooding of the river between the dam and Copco No. 1 Reservoir, the Shasta TCR sites located along this reach of the Klamath River would not be subject to short-term erosion and/or flood disturbance related to the removal of J.C. Boyle Dam.

Many of the Shasta TCR sites located along the river in this reach are located within the current FEMA 100-year floodplain. Because J.C. Boyle Reservoir is not a flood control reservoir, the FEMA 100-year floodplain extent in the Klamath River between J.C. Boyle Dam and Copco No. 1 Reservoir would not change with dam removal (see Appendix K). Thus, there would be no long-term change in the flooding potential for Shasta TCR sites due to removal of J.C. Boyle Dam. Overall, there would be no significant impact of the

Proposed Project on Shasta TCR sites located between J.C. Boyle Dam and Copco No. 1 Reservoir.

Middle Klamath River

Known TCRs within the Area of Analysis *Subarea 2* (Figure 3.12-3) include resources identified in PacifiCorp (2004) and Daniels (2006), as updated by Confidential Appendix Q, Attachment 4, and are cataloged in Confidential Appendices P and Q. Resources identified as villages, cairns or burial sites, or sites eligible for the National Register of Historic Places in a subsequent compilation by Cardno ENTRIX (2012) were also considered as part of this analysis.

Under the Proposed Project, drawdown of the four reservoirs would occur simultaneously beginning in January of dam removal year 2 (Copco No. 1 Reservoir would also experience early drawdown starting November of dam removal year 1 at a lower rate) (see also Section 2.7.2 *Reservoir Drawdown*). Drawdown of Copco No. 2 may occur later, at the start of May of dam removal year 2. The reservoir releases would be controlled and would vary by reservoir depending on the type of dam, discharge capacity, water year type, and the volume of water and sediment within the reservoir (Appendix B: *Definite Plan*). The proposed drawdown of the Lower Klamath Project reservoirs is designed to minimize potential flood risks, including drawing down the reservoirs using controlled flow releases and the increased storage availability in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs once drawdown has begun to accommodate for winter flow events. If a flood event occurred during drawdown, the flood flows would be retained using the newly available storage capacity in each reservoir and drawdown would continue after flood risks have ended. Current conditions do not allow the Lower Klamath Project reservoirs to assist in flood prevention in this manner as the reservoirs' current operations occur within a narrow reservoir storage rage and do not provide adequate space for storage of winter flows. The Proposed Project drawdown rates are consistent with the historical discharge rates from the reservoirs, where flow rates downstream of the dams would not increase substantially above median historical rates, if at all. Discharges from Copco No. 1 and Iron Gate reservoirs would be similar to, or less than, seasonal 10-year flood flows from the reservoirs (see also Potential Impact 3.6-1).

Thus, drawdown releases from the Lower Klamath Project dams would not cause flooding of the Middle and Lower Klamath River, riverside TCR sites located in Area of Analysis *Subarea 2* (Figure 3.12-3), downstream of Iron Gate Dam either along the reach from Iron Gate Dam (RM 193) to Humbug Creek (RM 174) or further downstream. Therefore, these resources would not be subject to increased short-term erosion or flood disturbance as a result of reservoir drawdown that could destroy or materially alter TCRs in a way that would undermine current or historical cultural significance.

However, hydrologic and hydraulic modeling of floodplain inundation shows that removal of the Lower Klamath Project dams could result in minor alterations to the FEMA 100-year floodplain inundation area downstream of Iron Gate Dam, along the 18-river mile stretch of the Middle Klamath River between RM 193 and 174 (i.e., from Iron Gate Dam to Humbug Creek) (USBR 2012c). Changes in the extent of the floodplain inundation area could increase the risk of flood damage to TCRs that are not currently located within the FEMA 100-year floodplain but would be following dam removal, where flood damage could involve physical destruction or relocation of TCRs such that the significance of the TCR would be materially impaired. This would be a significant impact in the short term and long term. Implementation of TCR-1, TCR-2, and TCR-3 would reduce impacts, although for the reasons described in Potential Impact 3.12-1, the impacts would remain significant and unavoidable.

Lower Klamath River and Klamath River Estuary
Because drawdown is not expected to increase flood risk and because dam removal is not expected to alter the floodplain downstream of Humbug Creek, no increased erosion or flooding-related risk of damage to cultural resources is expected over the current conditions in these areas in either the short term or the long term.

There is the potential for the morphology of the Klamath River Estuary to change in light of sediment releases from the drawdown of the reservoirs (see Potential Impact 3.2-3). These changes to the estuary have a low-risk potential to affect estuary-based Yurok Tribe TCRs; however, there is some risk of potential impacts that would not occur absent implementation of the Proposed Project. The Yurok Tribe has adopted ordinances and policies to address impacts to cultural resources on the Yurok Reservation, which includes the Klamath River Estuary. In the unlikely event that such Proposed Project-related impacts would occur to resources in the area of the Klamath River Estuary, implementation of Mitigation Measure TCR-5 would reduce the potential impacts to less than significant.

Mitigation Measure TCR-5 – Implementation on Yurok Reservation.
Mitigation Measures TCR-1, TCR-2, and TCR-3 do not apply on the Yurok Reservation. The Yurok Tribe's Cultural Resource Ordinance and Inadvertent Discovery Policy shall apply to such TCRs on the Yurok Reservation.

Significance
No significant impact in the short term or long term for the Hydroelectric Reach between J.C. Boyle Dam and Copco No. 1 Reservoir

Significant and unavoidable with mitigation in the short term and long term for the Middle Klamath River from Iron Gate Dam to Humbug Creek

No significant impact in the short term or long term for Middle Klamath River downstream of Humbug Creek and Lower Klamath River excluding the Yurok Reservation (approximately RM 0 to RM 45)

No significant impact with mitigation on the Yurok Reservation (approximately RM 0 to RM 45) along Lower Klamath River and Klamath River Estuary

Potential Impact 3.12-4 Project activities associated with removal of Iron Gate, Copco No. 1, and Copco No. 2 dams could result in physical disturbance to known or unknown tribal cultural resources from blasting or other removal techniques.
Blasting and other dam removal techniques could cause significant adverse impacts to known or unknown TCRs located in the immediate vicinity[149] of Iron Gate, Copco No.1 and Copco No. 2 dams. While minor ground vibration and sounds from blasting and other dam removal techniques may extend throughout the 0.25-mile distance from each

[149] For the purposes of this analysis, "immediate vicinity" is defined as within 0.25 miles of Copco No. 1, Copco No. 2, and Iron Gate dams.

of the dams, the vibration and sounds would not result in significant impacts to TCRs because they would not result in physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of the TCR would be materially impaired.

However, direct physical disturbance associated with blasting and other removal techniques could significantly impact those TCR sites that directly overlap with the blasting locations. The KRRC proposes complete removal of dam facilities, including, in some instances, excavation of concrete below the existing streambed level, in order to prevent future development of fish barriers as the river morphology changes. Removal of the concrete dam structures would require blasting and drilling which could destroy, relocate, or alter those TCRs sites that directly overlap with the blasting locations or their immediate surroundings such that the significance of these TCRs would be materially impaired.

There is at least one TCR that was present before dam construction that would be potentially impacted. It is unknown the extent to which the resource survives currently as it is no longer accessible. To the extent the site still exists, removal of the dam has a high likelihood of significantly degrading the site. There is also the potential for as-yet unknown sites to be impacted within the blasting zone, or by other techniques associated with the removal of these features, in light of the density of sites in the Hydroelectric Reach.

Implementation of mitigation measures TCR-1 (TCRMP), TCR-2 (LVPP), TCR-3 (IDP), and TCR-4 (Endowment)[150] would reduce impacts to TCRs associated with dam removal activities, but impacts would remain significant and unavoidable.

Significance

Significant and unavoidable with mitigation

Potential Impact 3.12-5 Ground disturbance associated with reservoir restoration, recreation site removal and/or development, and disposal site restoration could physically disturb known Tribal Cultural Resources. Additionally, ongoing road and recreation site maintenance has the potential to disturb known Tribal Cultural Resources.

The proposed Reservoir Area Management Plan includes restoration activities that would occur both within the reservoir footprint and in upland areas (i.e., disposal, staging, and hydropower infrastructure demolition areas, access roads, former recreational areas) within the Area of Analysis *Subarea 1* (Figure 3.12-2). Known TCR locations include those reflected in PacifiCorp (2004) and Daniels (2006), and as updated by Confidential Appendix Q, Attachment 4, which are cataloged in Confidential Appendices P and Q. Resources identified as villages, cairns or burial sites, or sites eligible for the National Register of Historic Places in a subsequent compilation by Cardno ENTRIX (2012) were also considered as part of this analysis.

[150] Mitigation Measures TCR-6, TCR-7 and TCR-8 could also further reduce the potential impact. However, at this point it is not clear whether the measures are feasible (see Potential Impact 3.12-9). Therefore, this EIR does not rely on implementation of these measures, in reaching its significance determinations.

After reservoir drawdown, the following ground-disturbing activities would be implemented in the former reservoir areas to stabilize remaining sediments over time and to restore riparian, floodplain, and wetland habitats:

- Active seeding[151] via ground equipment to revegetate reservoir areas with native grasses, sedges, rushes and forbes immediately after reservoir drawdown and planting of acorns, shrub seedlings, and pole cuttings as early as feasible;
- Manual removal/treatment of invasive exotic vegetation, which may include manual weed extraction, solarization (covering round areas with black visqueen), tilling, and use of herbicides;
- Planting of woody riparian trees and shrubs along the river banks in the former reservoir areas; and
- Installation of floodplain and off-channel habitat features such as large wood, roughening of the floodplain to enhance establishment of vegetation, and rectifying any non-natural fish passage barriers in mainstems and tributaries.

Within the reservoir footprint portions of the Area of Analysis *Subarea 1*, numerous TCR sites have been identified, including prehistoric archaeological sites with habitation debris, village sites, house pits and rock features and burial sites; as well as ethnographic places and other features of the cultural landscape (Confidential Appendices P and Q). Additionally, there may be many as-yet unknown TCRs located within the footprints of Copco No. 1, Copco No. 2, and Iron Gate reservoirs. Artifacts within the reservoir footprint may be materially impaired through physical demolition, destruction, relocation, or alteration by construction equipment (e.g., tilling) or hand tools (e.g., shovels for planting trees) during the aforementioned reservoir restoration activities. The proposed Reservoir Area Management Plan also includes long-term monitoring of vegetation growth, invasive exotic vegetation, and fish passage to ensure objectives are accomplished; however, these activities are not expected to be ground-disturbing.

Within the upland portions of the Area of Analysis *Subarea 1* (i.e., outside of the Copco No. 1 and Iron Gate reservoir footprints, including the fluctuation zone), known TCRs include those reflected in PacifiCorp (2004) and Daniels (2006), and as updated by Confidential Appendix Q, Attachment 4, and are cataloged in Confidential Appendices P and Q. Resources identified as villages, cairns or burial sites, or sites eligible for the National Register of Historic Places in a subsequent compilation by Cardno ENTRIX (2012) were also considered as part of this analysis. Proposed upland restoration activities include active management of invasive exotic vegetation species, which may include ground-disturbing activities such as manual weed extraction, solarization (covering of ground areas with black visqueen), tilling, and planting (Appendix B: *Definite Plan − Appendix H*) (see also Section 2.7.5 *Restoration of Upland Areas Outside of the Reservoir Footprint*). These activities may result in material impairment of TCRs located

[151] The Reservoir Area Management Plan includes aerial pioneer seeding using helicopters during the winter/early spring during and following reservoir drawdown (Appendix B: *Definite Plan – Appendix H*). Aerial seeding is not a ground-disturbing activity. Fall overseeding, which is potentially ground-disturbing, would be completed with a ground-based broadcast seeder over the mowed or rolled vegetation remaining from the pioneer seeding (Appendix B: *Definite Plan – Appendix H*). Hydroseeding via barge during reservoir drawdown is potentially a ground-disturbing activity, although this activity is not currently anticipated by KRRC. Potential impacts due to barge hydroseeding are discussed in Impact 2.

within upland portions of the Area of Analysis *Subarea 1* from physical demolition, destruction, relocation, or alteration by construction equipment (e.g., tilling) or hand tools (e.g., shovels for planting trees). Non-ground-disturbing, proposed upland restoration activities include the possible use of herbicides for controlling invasive exotic vegetation; collecting seeds for local nurseries to grow trees and shrubs; and implementing a short-term Storm Water Pollution Prevention Plan (SWPPP)/Erosion Control Plan.

Ground-disturbing activities associated with ongoing road and recreation site maintenance within the Area of Analysis *Subarea 1* (Figure 3.12-2) include grading and excavating, which may also result in material impairment due to physical demolition, destruction, relocation, or alteration of TCRs located in both upland and reservoir footprint locations.

In summary, several known and potentially many as-yet unknown TCRs could be significantly adversely impacted due to the aforementioned ground-disturbing activities associated with revegetation and restoration of riparian, floodplain, and wetland habitat within former reservoir areas and upland areas, as well as ongoing road maintenance and potential recreation site construction and maintenance, if any.

Implementation of Mitigation Measures TCR-1 (TCRMP), TCR-2 (LVPP), TCR-3 (IDP), and TCR-4 (Endowment)[152] would reduce these impacts considerably, and, for most resources is expected to avoid impacts completely, through designing restoration plans to completely avoid impacts, or by on-the-ground changes to implementation to avoid impacts. Using hand tools to restores sensitive areas will reduce the risk and severity of potential damage as compared to use of heavy equipment. For impacts that it is not feasible to completely avoid, the impacts may be reduced to a less than significant level. The measures include, among other requirements, field worker training, limits to worker and public access, tribal monitors, surveys, and identification of protocols and best practices upon discovery or disturbance of TCRs in project implementation. With timely discovery and appropriate steps to address exposure or damage, many TCRs can maintain their current level of cultural significance. Additionally, providing a means for the long-term protection or enhancement of affected TCRs can mitigate for some impacts.

However, the impact of exposing or disturbing tribal human remains, or associated funerary items, is itself profound. The mitigation measures are expected to considerably reduce - but cannot be reasonably be expected to completely avoid - such exposure or disturbance, particularly in light of the density of villages in the reservoir bed areas. While treating remains and associated funerary objects with the appropriate respect and procedures can reduce and avoid compounding the harm from the initial damage, it cannot do so fully.

Additionally, in light of the high density of TCRs in the restoration areas, and because some of the contemplated restoration involves significant earth-moving with heavy equipment, such as potentially regrading areas and enhancing wetlands, significant risk remains that other TCRs may sustain damage that results in a martial impairment of the

[152] Mitigation Measures TCR-6, TCR-7 and TCR-8 could also further reduce the potential impact. However, at this point it is not clear whether the measures are feasible (see Potential Impact 3.12-9). Therefore, this EIR does not rely on implementation of these measures, in reaching its significance determinations.

resource's significance. In light of the particular harm of exposing human remains even where they are treated appropriately after exposure, and the likelihood of significantly impairing other resources in light of the type of construction actions and the density of resources, the impact would remain significant and unavoidable.

Significance
Significant and unavoidable with mitigation

Potential Impact 3.12-6 During and following reservoir drawdown activities at Iron Gate, Copco No. 1, and Copco No. 2 reservoirs there is an increased potential for looting of Tribal Cultural Resources (short-term and long-term).
During and immediately following reservoir drawdown[153], TCRs located within the footprints of Copco No. 1, Copco No. 2, and Iron Gate reservoirs would no longer be partially or completely covered by reservoir waters and thus would be more accessible and at greater risk for looting. For these known TCR sites, plus as-yet unknown sites, some tribal representatives assert that the reservoirs offer the best protection against looting because the reservoir waters currently prevent looter access.

Known TCRs within the Area of Analysis *Subarea 1* (Figure 3.12.2) include resources identified in PacifiCorp (2004a) and Daniels (2006), as updated by Confidential Appendix Q. Resources identified as villages, cairns or burial sites, or sites eligible for the National Register of Historic Places in a subsequent compilation by Cardno ENTRIX (2012) were also considered as part of this analysis. Within the footprints of Copco No. 1, Copco No. 2, and Iron Gate reservoirs, which is the focus of this Potential Impact 3.12-5 analysis, numerous TCR sites have been identified. Additionally, there may be many as-yet unknown TCRs located within the footprints of the California reservoirs. Note that many of the known TCR sites are located within the reservoir fluctuation zones and several of these are associated with relatively shallow sediment deposits (approximately 0.2 to 2 feet deep). Tribal cultural resource sites located within the reservoir fluctuation zones may be periodically at risk of looting during low water periods under existing conditions.

Within the reservoir footprints, Proposed Project restoration activities would occur during and immediately following reservoir drawdown (i.e., dam removal years 1 and 2) as well as post-dam removal year 1, including active seeding to revegetate reservoir areas with native grasses, sedges, rushes and forbes, and planting of acorns, shrub seedlings, and pole cuttings, all of which would stabilize sediments remaining in the reservoir footprints (see also Potential Impact 3.12-4). Revegetation activities would reduce erosion of fine sediments (Appendix B: *Definite Plan – Appendix H*) and would physically cover the remaining sediment deposits with a variety of vegetation, thus decreasing the potential for exposure and looting of TCRs located within the reservoir footprints. However, in general, sensitive areas located within the reservoir footprints would be subject to exposure and increased access since they would no longer be partially or completely covered by reservoir waters. This could increase the potential for looting of TCRs above levels occurring under existing conditions. The potential severity of this impact is underscored by significant anecdotal evidence of an extensive looting problem in the

[153] Consideration of exposure or substantial movement of tribal cultural resources during pre-dam removal ground-disturbing activities that could lead to increased access and looting above levels occurring under existing conditions is discussed in Potential Impact P-1.

area, and by statements made by tribal members regarding the deep impact of past and ongoing looting, particularly in light of a history of repeated dispossession in the area.

Implementation of Mitigation Measure TCR-2 (LVPP) and TCR-4 would significantly reduce the impacts of looting in the short term and long term. However, illegal looting remains a pervasive problem in the vicinity, as related through extensive anecdotal evidence by tribal members and archaeologists with experience in the area. Therefore, although it is likely that the LVPP would be effective in protecting most resources through the intensive monitoring and broad range of tools to address the concern, it would be unlikely to be completely effective. The impact of looting of certain resources is profound, and could result in material impairment of a resources' significant or result in the exposure or disturbance of human remains. Therefore, the increased risk of looting remains significant and unavoidable.

Significance

Significant and unavoidable with mitigation in the short term and long term

Potential Impact 3.12-7 Short-term erosion caused by high-intensity and/or duration precipitation events could cause exposure of or disturbance to known or unknown tribal cultural resources within the reservoir footprints immediately following reservoir drawdown and prior to vegetation establishment/full stabilization of sediment deposits.

Immediately following reservoir drawdown[154], high-intensity and/or long-duration precipitation events could occur that would result in surface erosion of remaining reservoir sediment deposits and cause exposure of or disturbance to TCRs located within the reservoir footprints. Known TCRs to be within the Area of Analysis *Subarea 1* include resources identified in PacifiCorp (2004a) and Daniels (2006), as updated by Confidential Appendix Q. Resources identified as villages, cairns or burial sites, or sites eligible for the National Register of Historic Places in a subsequent compilation by Cardno ENTRIX (2012) were also considered as part of this analysis. Within the footprints of Copco No. 1, Copco No. 2, and Iron Gate reservoirs, which is the focus of this analysis for Potential Impact 3.12-7, numerous TCR sites have been identified (Confidential Appendices P and Q). Additionally, there may be many as-yet unknown TCRs located within the footprints of Copco No. 1, Copco No. 2, and Iron Gate reservoirs.

Since the Lower Klamath Project reservoirs were constructed, fine sediments composed primarily of organic material (including dead algae), but also including some silts and clays, have accumulated along the reservoir bottoms (see Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*). The distribution of sediment deposits varies within each reservoir (Figure 2.7-8 and 2.7-9). Because the accumulated sediments are primarily fine material, a percentage of them would be easily eroded and flushed out of the reservoirs into the downstream Klamath River during reservoir drawdown, with the majority of the erosion focused in the original river channel (Figures 2.7-5 and 2.7-6). However, following drawdown, 40−60 percent of the sediment deposits accumulated behind the dams would remain in place in each of the former reservoir beds, primarily on terraces located above the original river channel. The sediments that remain in the reservoir footprints would consolidate (dry out and

[154] Consideration of potential shifting-, erosion-, and exposure-related impacts to tribal cultural resources during reservoir drawdown is discussed in Potential Impact 3.12-2.

decrease in thickness) (USBR 2012a), making them less subject to erosion. Further, during the drawdown period, seeding (by helicopter and potentially barge) of pioneer mixes would occur as the reservoir water level drops and before the exposed reservoir sediments dry and form a surface crust. The seeded native grasses are expected to become well established within weeks after application (January to March of dam removal year 2), which would reduce erosion of the remaining reservoir sediment deposits during cycles of wetting (i.e., from precipitation events) and drying (Appendix B: *Definite Plan – Appendix H*). During the first summer and fall following reservoir drawdown (dam removal year 2), additional seeding application would occur including grasses and ground cover, with monitoring and targeted revegetation for areas that do not meet vegetation cover goals (Appendix B: *Definite Plan – Appendix H*).

During the period of weeks when seeded native grasses have not yet become well established within the reservoir footprints, high intensity and/or long-duration precipitation events could increase erosion of remaining reservoir deposits through sediment cracking and gully erosion, and destroy or materially impair TCRs in a way that would undermine current or historical cultural significance, including through substantial movement of human remains. This could increase disturbance impacts to TCRs that were already affected during drawdown (see Potential Impact 3.12-4), or impact additional TCRs that were not affected by erosion during drawdown. The risk of this occurring would be higher for TCRs located in areas where post-reservoir sediment deposition was relatively thin (i.e., areas where sediment deposits are less than 2 feet deep) and would be limited to TCRs that were located above ground prior to reservoir inundation[155].

However, since 40−60 percent of the reservoir sediment deposits are predicted to remain in place following drawdown, many TCRs that were located above ground at the time of reservoir inundation are expected to remain substantially covered, even those located within reservoir sediment deposits that are less than 2 feet deep (see Confidential Appendices P and Q). For those sites located within deeper reservoir sediment deposits, the overlying sediment layer would offer protection from surface cracking and gully erosion that may result from high intensity and/or duration precipitation events and these deeper sites would not be likely to be destroyed or materially impaired in a way that would undermine current or historical cultural significance.

The risk of continued erosion and subsequent exposure of or disturbance to TCRs located in the reservoir footprints, particularly for those associated with relatively shallow (e.g., less than 2 feet deep) sediment deposits (see Confidential Appendices P and Q), would decrease within weeks to months following reservoir drawdown as revegetation stabilizes the remaining sediments. Monitoring and targeted revegetation activities included in the proposed Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) would reduce the risk of impacts to TCRs located in areas of large crack or gully formation. As the system returns to riverine conditions within the reservoir

[155] For tribal cultural resources that were located below ground prior to inundation, the Proposed Project is not expected to result in exposure or disturbance impacts because sediment erosion would be limited to the fine materials accumulated since the reservoirs were constructed (see Potential Impact 3.12-2). These tribal cultural resources would remain buried, their significance to the Shasta Nation would not be materially impaired, and there is no anticipated impact.

footprints, with revegetated terraces along the river and sides of the former reservoirs, long-term erosion and sediment transport rates would return to natural rates for this portion of the watershed (USBR 2012c).

Implementation of Mitigation Measures TCR-1 (TCRMP), TCR-2 (LVPP), and TCR-3 (IDP)[156] would reduce these impacts, overall they would remain significant and unavoidable for the reasons described for the erosion related to reservoir drawdown (Potential Impact 3.12-2).

Significance

Significant and unavoidable with mitigation in the short term

Potential Impact 3.12-8 Long-term (post-removal) impacts to Tribal Cultural Resources as a result of dam removal from increased looting opportunities and from surface and subsurface erosion of Tribal Cultural Resources.

Following drawdown of Iron Gate, Copco No.1, and Copco No. 2 reservoirs, 40−60 percent of the reservoir sediment deposits would remain in place, primarily on areas at higher elevation than the active river channel within the reservoir footprints (see also Potential Impacts 3.12-4 and 3.12-8). During tribal consultations, some tribal representatives expressed strong concerns that long-term erosion of remaining sediment deposits within the Lower Klamath Project reservoirs would disturb or destroy TCRs that are located there (see also Confidential Appendix P). In addition, the Proposed Project includes transfer of PacifiCorp lands immediately surrounding the Lower Klamath Project ("Parcel B lands") from PacifiCorp to the KRRC prior to dam removal, where Parcel B lands contain all of the Copco No. 1 Reservoir footprint and the majority of the Iron Gate Reservoir footprint (Figure 3.12-5). The Proposed Project then provides that the KRRC would transfer Parcel B lands to the respective states (i.e., California, Oregon), as applicable, or to a designated third-party transferee, following dam removal. The lands would thereafter be managed for public interest purposes (KHSA Section 7.6.4.A).

The potential for increased looting opportunities and surface erosion to result in long-term impacts to known or unknown TCRs due to the Proposed Project is discussed below for resources located within the reservoir footprints and within Parcel B lands.

Tribal Cultural Resource Sites Within the Reservoir Footprints Prior to Land Transfer

Tribal cultural resources known to the Shasta Nation to be within the Area of Analysis *Subarea 1* include resources identified in PacifiCorp (2004a) and Daniels (2006), as updated by Confidential Appendix Q, Attachment 4. Resources identified as villages, cairns or burial sites, or sites eligible for the National Register of Historic Places in a subsequent compilation by Cardno ENTRIX (2012) were also considered as part of this analysis. Within the footprints of Copco No. 1, Copco No. 2, and Iron Gate reservoirs, numerous TCR sites have been identified including village and cairn sites (Confidential Appendices P and Q). Additionally, there may be many as-yet unknown TCRs located within the footprints of Copco No. 1, Copco No. 2 and Iron Gate reservoirs.

[156] Mitigation Measures TCR-6, TCR-7 and TCR-8 could also further reduce the potential impact. However, at this point it is not clear whether the measures are feasible (see Potential Impact 3.12-8). Therefore, this EIR does not rely on implementation of these measures, in reaching its significance determinations.

As described in Potential Impacts 3.12-2 and 3.12-6, following reservoir drawdown, the remaining sediment deposits would consolidate through air drying and would decrease in thickness (USBR 2012a). Revegetation efforts under the Proposed Project would support re-establishment of native species on newly exposed reservoir sediments, including grasses and woody riparian species, where the latter would be planted at densities of several hundred plants per acre. It is expected that former wetland areas within the reservoir footprints would revert to wetland vegetation without long-term active revegetation inputs (Appendix B: *Definite Plan – Appendix H*).

While a portion of the fine sediments that have deposited since the dams were constructed would erode rapidly during reservoir drawdown (see Potential Impacts 3.12-4 and 3.12-8), erosion rates would decrease over weeks to months, as the remaining sediment deposits are stabilized by drying and by active and passive revegetation. As the system returns to riverine conditions within the reservoir footprints, long-term erosion and sediment transport rates would also return to natural rates for this portion of the watershed (USBR 2012c). Previous wave action within the reservoir fluctuation zone would cease as the reservoir shoreline would no longer exist, with a long-term benefit over current conditions to the known and as-yet unknown TCR sites located within the reservoir fluctuation zone (Confidential Appendices P and Q).

Thus, in the long term, drying, consolidation, and stabilization (due to re-vegetation) of the remaining sediment deposits would substantially limit the potential for erosion to result in exposure or substantial movement of TCRs buried within the deposits, or those that were located below the ground surface prior to construction and inundation of Copco No.1, Copco No. 2, and/or Iron Gate dams, such that increased access and looting above levels occurring under existing conditions would be unlikely. Instead, long-term drying, consolidation, and stabilization of the sediment deposits remaining in the reservoir footprints have the potential to preserve and protect known or as-yet unknown TCRs within or beneath the deposits. The potential for long-term erosion-related impacts on TCRs within the reservoir footprints is therefore different from and significantly less than the potential for erosion-related impacts to these resources in the periods during and immediately following reservoir drawdown (Potential Impact 3.12-4). However, despite the protection offered from the remaining sediment deposits, the vulnerability of existing TCRs to long-term exposure due to natural rates of erosion and sediment transport for the watershed would still increase as compared to existing conditions where the reservoir waters offer almost complete protection from access and looting (with the exception of resources located within the reservoir fluctuation zone). The potential impact of this increased potential is underscored by significant anecdotal evidence of an extensive looting problem in the area, and by tribal members' testimony regarding the deep impact of past and ongoing looting, particularly in light of a history of repeated dispossession in the area.

Implementation of Mitigation Measure TCR-1 (TRMP), TCR-2 (LVPP), and TCR-3 (IDP), would reduce long-term impacts to TCRs from increased looting opportunities and surface and subsurface erosion, however, these impacts would remain significant.

Tribal Cultural Resource Sites Within Parcel B Lands After Transfer

Known TCRs within the Area of Analysis *Subarea 4* (Figure 3.12-5) include resources identified in PacifiCorp (2004a) and Daniels (2006), as updated by Confidential Appendix Q, Attachment 4. Resources identified as villages, cairns or burial sites, or sites eligible for the National Register of Historic Places in a subsequent compilation by Cardno ENTRIX (2012) were also considered as part of this analysis. Numerous TCR sites have been identified completely inside or partially inside Parcel B lands (Confidential Appendices P and Q).

It is unknown what public use the lands in Parcel B would ultimately serve. The California Natural Resources Agency (CNRA) and California Department of Fish and Wildlife (CDFW) have begun speaking with interested stakeholders on various recreation, water quality, tribal, resource protection, conservation, and economic uses of the land, including with tribal governments and Siskiyou County representatives. While the lands would be managed for public interest, this could include a range of uses, including open space, active wetland and riverine restoration, river-based recreation, grazing, and potentially other uses. Certain future land uses (e.g., open space) would presumably result in less potential for impacts to TCRs.

However, certain land uses, if undertaken in areas with TCRs, would have the potential to increase public access to TCRs beyond the level of simply removing the reservoirs, and it could therefore result in additional impacts due to construction, looting, illegal excavation, vandalism, and other destruction or damage within the Area of *Subarea 4* (Figure 3.12-5). Existing and potentially new recreation facilities along the river corridor may also direct the public to favorable landforms (e.g., flat topography, close to tributary confluences and other water sources) that coincide with locations chosen by tribal ancestors for habitation and other cultural uses. Increased access to TCRs due to land transfer has the potential to lead to looting above levels occurring under existing conditions or to land uses that result in material alteration of TCRs in a way that would undermine their current or historical tribal significance.

Further, future Parcel B land transfer could result in uses of lands currently not submerged that eliminate or substantially restrict access of tribal members to TCRs during ceremonial windows or periods of hunting and gathering or other traditional activities associated with a TCR. It is unclear what public use of Parcel B lands could result in such an increased barrier over the existing private ownership by PacifiCorp. For currently submerged lands, there is currently no access such that future land use decisions for the reservoir footprint portions of Parcel B would likely result in access-related benefits as compared with existing conditions.

In 2017, the Kikaceki Land Conservancy was formed, which includes representation of Shasta people with ancestry in the area affected by the Proposed Project. In the ongoing consultation process under NHPA section 106, KRRC will address whether this existing land conservancy, or other entities which represent Affected Tribes, could continue to implement measures for TCR protection and enhancement after the KRRC has completed Project implementation. The express mention of the Kikaceki Land Conservancy in this EIR in no way excludes the claims of any other traditionally and culturally affiliated tribes, or harms any other tribes' rights.

The process for determining future land use under the KHSA Section 7.6.4 has the potential to offer TCRs appropriate protection through a variety of land use strategies: that process remains unaltered by this EIR. Implementation of TCR-6 (Land Transfer), TCR-7 (Land Easement and Transfer Stipulations), and TCR-8 (Off-site Land Transfer) have the potential to reduce the impact of future land use decisions to less than significant. These measures are in alignment with the general proposed measures for consideration to mitigate impacts to TCRs described in Public Resources Code section 21084.3, subdivision (b)(3).

However, the ultimate feasibility of these measures is uncertain. The process for determining future land uses under KHSA Section 7.6.4 has not advanced to the point at which competing uses, financial limitations, parcel access requirements, or other constraints have become clear. Additionally, because the KRRC has a set amount of funding with which to implement the Proposed Project, its ability to undertake purchase of lands outside Parcel B as a mitigation measure is also uncertain, and thus the feasibility of Mitigation Measure TCR-8 (Off-site Land Transfer) is also uncertain. Because the ultimate feasibility of these measures is uncertain, and the State Water Board lacks the authority to impose them through its Clean Water Act section 401 certification, this EIR does not rely on implementation of these measures, although it is disclosing them because it is likely that the protections would be viable for at least some portion of the identified lands, and because they represent a potentially feasible path to protect TCRs.

Mitigation Measure TCR-6 – Land Transfer.
The State Water Board has determined, and KRRC has acknowledged, that transfer of some Parcel B lands to an entity representative of Affected Tribes which are traditionally and culturally affiliated with TCRs on such lands, could foster tribal cultural and conservation practices and promote tribal identity; and further, that such transfer could be an appropriate measure to address past disturbance of TCRs caused during construction of Iron Gate Dam, Copco No. 1 Dam, and Copco No. 2 Dam, and to mitigate the impacts to TCRs caused by Project implementation.

Pursuant to KHSA Section 7.6.4, the California Natural Resources Agency (CNRA) and CDFW have begun the process to determine the disposition of Project-related (or “Parcel B”) lands, totaling approximately 8,000 acres, for public interest purposes. In California, that process is anticipated to involve the following steps: (1) inspections and preliminary due diligence regarding the condition of the Parcel B lands; (2) consultation with KHSA parties and other stakeholders regarding disposition; (3) for each parcel, a proposal by CNRA and CDFW regarding proposed transferee and other terms; (4) actual transfer of Parcel B lands from PacifiCorp to KRRC, upon KRRC’s notice that it has secured all necessary permits for dam removal; and (5) subsequent transfer from KRRC to California or the third-party transferee, by parcel.

Based on AB 52 consultation, the State Water Board has identified the following potential mitigation measure, which is dependent on the outcome of the process required by KHSA Section 7.6.4. The Shasta Indian Nation has proposed the transfer of selected Parcel B lands (as identified in Confidential Appendix Q they have identified as possessing the most significant tribal cultural value to the Shasta Indian Nation and also having central importance to other Shasta peoples. The Shasta Indian Nation has proposed transfer to an entity, such as the Kikaceki Land Conservancy, that includes representation of the several bands of Shasta peoples. While it is too early in the process to determine the feasibility of such transfer, this measure is included for analysis in the Environmental Impact Report. In the process required by KHSA Section 7.6.4, the KRRC shall support consideration of transfers of selected lands to an entity representative of Affected Tribes that are traditionally and culturally affiliated with the TCRs on such lands, in circumstances where the lands have resources of critical tribal importance and such transfer would be a cost-effective approach to protect such resources.

Mitigation Measure TCR-7 – Proposal for Land Easement and Transfer Stipulations. The CNRA and CDFW have begun initial discussions in a stakeholder process for determining land disposition as described in KHSA Section 7.6.4, including discussions with Shasta people.

1. For TCRs and such sites that are protected under Public Resources Code 5097.993, land easement and transfer stipulations could ensure that protection measures described in the TCRMP encumber the title for all subsequent owners for other lands not returned to the Shasta people. Any such land easement or transfer stipulations shall be consistent with KHSA Section 7.6.4 and other applicable terms.
2. There is also the potential to coincide public wildlife conservation management areas with lands that contain tribal cultural values to restrict public access where feasible and promote protection of cultural sites.
3. These mechanisms can also provide the opportunity for Shasta people to access TCRs through creation of tribal conservation easements.

Mitigation Measure TCR-8 – Off-site Land Transfer.
At any time prior to completing the TCRMP, the KRRC may identify parcels of land not subject to the process under KHSA Section 7.6.4, that may be appropriate for transfer to an entity representative of Affected Tribes (such as the Kikaceki Land Conservancy), as off-site mitigation for Project-related impacts to TCRs. Any such transfer involving the KRRC is subject to funding availability consistent with the terms (including funding authorities) of the KHSA.

Significance
Significant and unavoidable prior to land transfer

No significant impact with mitigation after land transfer

Potential Impact 3.12-9 Klamath Cultural Riverscape Contributing Aspect – Combined effects on the Klamath River fishery of dam removal, changes in hatchery production, and increased habitat for salmonids.
Many California Native American tribes located in the Klamath River Basin historically relied on fish (such as salmon, steelhead, and Pacific lamprey) for food, currently use fish in their diet, including some members at a subsistence level of reliance, and have and continue to consider fish to be an important part of their culture (Section 3.12.2 *[Historical Resources and Tribal Cultural Resources] Environmental Setting* and Appendix V – 2012 KHSA EIS/EIR *Section 3.12 Tribal Trust*). Under existing conditions, these fish may include adult Chinook and coho salmon returns to Iron Gate Hatchery. CDFW operates Iron Gate Hatchery with an annual production goal (CDFW 2014) (see also Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project – Fish Hatcheries*) of 75,000 coho salmon smolts, and six million fall-run Chinook salmon yearlings and smolts.

The ability to meet the above production goals varies annually based on adult returns and hatchery performance. Coho salmon production has averaged 75,000 yearlings (achieving production goals) and 866 adult returns on an annual basis (CDFW 2014). Coho returns to Iron Gate Hatchery have significantly and steadily declined from a high of 2,466 adults in the 2001/2002 return year to a low of 38 adults in the 2015/2016 return year (CDFW 2016). From 2005 through 2018 actual fall-run Chinook salmon yearling production has averaged 955,931 (exceeding production goals), and actual smolt production has averaged 4,276,728 (around a million fewer smolts than the goal on average) (K. Pomeroy, CDFW, pers. comm., 2018). The fall-run Chinook salmon hatchery spawner return goal is 8,000 fish. Total Chinook salmon returns to Iron Gate Hatchery between 1978 and 2016 ranged from 2,558 to 72,474 and averaged 16,206 fish (CDFW 2017). From 2000 to 2016, adult winter steelhead returns to Iron Gate Hatchery averaged 242 and peaked at 631 in 2001 (CDFW 2016). Returns have been declining, and in 2016 no adult steelhead returned to the hatchery (CDFW 2016). The low adult returns of steelhead have resulted in no production of steelhead yearlings from Iron Gate Hatchery since 2012.

It appears that progeny from Iron Gate Hatchery releases have contributed appreciably to in-river tribal harvest since the late 1960s (PacifiCorp 2004a). PacifiCorp (2004a) estimates that based on smolt-to-adult survival studies conducted on Iron Gate fall Chinook salmon, the Iron Gate Hatchery production contributes about 50,000 fish annually to the Chinook and coho salmon fisheries (including commercial, tribal and recreational fisheries), in addition to escapement back to the hatchery.

The Proposed Project includes the continued operation of Iron Gate Hatchery and the reopening of Fall Creek Hatchery. The Iron Gate and Fall Creek hatcheries would be operated for eight years following dam removal (Section 2.7.6 *Hatchery Operations* and Section 3.3.5.6 *Fish Hatcheries*). The total production goals for both hatcheries would be reduced from the current production at Iron Gate Hatchery, whereby fall-run Chinook salmon smolts (both age 0 and age 1 yearling smolts) would be reduced by about 43 percent relative to current (2005 through 2018) releases, coho yearling production would remain the same, and steelhead production would continue to be zero.

Operation of the hatcheries at a combined reduced capacity following dam removal would be likely to reduce average annual hatchery Chinook salmon returns (by around 7,120 fewer fish) compared with existing conditions (Potential Impact 3.3-7) between post-dam removal years 3 and 10 (Table 3.3-11). There would be no change to the coho salmon population through dam removal year 9 relative to existing conditions as a result of shifting all coho production to Fall Creek Hatchery (Potential Impact 3.3-9) and there would be no change to steelhead production relative to existing conditions since steelhead have not been released since 2012.

No reduction in hatchery adult returns would be evident until post-dam removal year 3 (Section 3.3.5.6 *Fish Hatcheries*), by which time the first adult returns from the progeny of naturally spawning Chinook salmon in newly accessible habitat upstream of the prior location of Iron Gate Dam would occur (Potential Impact 3.3-7). Between post-dam removal years 3 and 10, both hatchery returns and returns from newly accessible habitat would occur, offsetting reductions due to lower hatchery capacity in the early years of the Proposed Project, as total adult returns of Chinook salmon, and the associated tribal fishery resource, increase towards overall higher levels.

The elimination of hatchery production after eight years following dam removal under the Proposed Project would eliminate the congregation of returning hatchery adults to the reach downstream of the prior location of Iron Gate Dam. Combined with the removal of the dams, which would increase the likelihood that adults would disperse further upstream, these factors would be likely to reduce the incidence of fish disease and parasites in the Klamath River (see Section 3.3.5.5 *Fish Disease and Parasites*). Further, since hatchery juveniles would no longer be released after post-dam removal year 7, fish disease would be less likely to affect outmigrating smolts. Higher smolt survival would result in an increase in adult returns available for in-river tribal harvest (PacifiCorp 2004a). Overall, it is anticipated that the Proposed Project would help to reduce the incidence of fish disease and parasites in the Klamath River and thus would be beneficial.

As described in Section 3.3.5.9, Potential Impact 3.3-7, quantitative modeling of fall-run Chinook salmon populations predict that the Proposed Project would increase Chinook salmon abundance. Median escapements to the Klamath Basin are predicted to be higher (median increase greater than 30,000) with the Proposed Project than under existing conditions. The potential for tribal harvest is therefore also predicted to be greater with the Proposed Project due to increased numbers of Chinook salmon adults (affecting the number of fish available annually), and the decrease in the probability of low escapement leading to fishery closures (affecting the number of years in which fishing will be available for more than ceremonial purposes).

While a reduction (around 7,120 fish on average) in total fall-run Chinook salmon returns for up to four years under the Proposed Project would constitute a potential short-term alteration in Chinook salmon as a tribal fishery resource, it is within the existing degree of annual variability in hatchery-origin Chinook salmon returns (2,558 to 72,474 for the period 1980 to 2001 [CDFW 2016b]) and natural Chinook salmon returns (6,957 to 91,757 for the period 1980 to 2001 [CDFW 2016a]). The Proposed Project would be unlikely to represent a material impairment of the Klamath Riverscape as a resource or a substantial restriction of tribal access to the fishery relative to existing conditions, even in the short term. This assessment is bolstered by the lack of reduction in hatchery-origin coho adult returns that would occur under the Proposed Project and the lack of change in hatchery operations from the existing condition for steelhead and spring-run Chinook (neither of which the hatchery produces) under the Proposed Project.

In addition, survival of natural and hatchery smolts is predicted to increase by post-dam removal year 1 from reduced incidence of disease (see Section 3.3.5.5 *Fish Disease and Parasites*) and increased natural production from newly accessible habitat is predicted to increase salmon abundance by post-dam removal year 3 (see Section 3.3.5.6 *Fish Hatcheries*). Thus, reduced hatchery production goals for eight years following dam removal would be a less than significant impact in the short term. In the long term, the loss of hatchery production would be more than replaced by increased natural production (Potential Impact 3.3-7), and the cessation of hatchery operations would be beneficial to the Klamath River fishery TCR by helping to reduce the incidence of fish disease and parasites.

As described in Section 3.3.5.9, the Proposed Project would not have a significant short-term impact and would have a long-term beneficial effect on spring-run Chinook salmon (Potential Impact 3.3-8), coho salmon (Potential Impact 3.3-9), steelhead (Potential Impact 3.3-10), Pacific lamprey (Potential Impact 3.3-11), and redband trout (Potential Impact 3.3-14). The tribal fishery resource is anticipated to benefit from the Proposed

Project in the long term as a result of population improvements for these tribal trust species.

As described in Section 3.3.5.9, the Proposed Project would not have a significant short- or long-term impact on green sturgeon (Potential Impact 3.3-12), Lost River and shortnose suckers (Potential Impact 3.3-13), eulachon (Potential Impact 3.3-15), longfin smelt (Potential Impact 3.3-16), and freshwater mussel species *M. falcata* and *G. angulate* (Potential Impact 3.3-16). Freshwater mussel *Anodonta spp*. would experience a significant and unavoidable impact under the Proposed Project (Potential Impact 3.3-16).

As discussed under Section 3.12.2.3 *Known Tribal and Historical Resources in the Vicinity of the Proposed Project [Klamath Cultural Riverscape]*, the influence of the Proposed Project on the riverscape as a whole, and overall ecosystem health, are more important than the individual potential impacts on specific species. Based on the assessment that there would be a short-term, less-than-significant effect on most tribally significant species (with the exception of *Anodonta ssp.*) under the Proposed Project; the relatively short duration of a predicted measurable decline in fall-run Chinook adult returns from reduced hatchery operations that falls within the existing variation of hatchery returns; the lack of predicted impact from the closure of the hatchery after eight years as compared to the existing conditions (i.e., baseline); the predicted increases in fish production and health from dam removal; and the long-term benefits on much of the key tribal trust species (e.g., Chinook salmon, coho salmon, steelhead, and Pacific lamprey) resulting from improved river ecosystem function and increased habitat access, the riverscape is anticipated to benefit under the Proposed Project.

<u>Significance</u>

No significant impact in the short term

Beneficial in the long term

Potential Impact 3.12-10 Klamath Cultural Riverscape Contributing Aspect: Ability of tribes to use the Middle and Lower Klamath River for ceremonial and other purposes due to alterations in riverine water quality and the extent of nuisance and/or noxious blue-green algae blooms.

California Native American tribes, such as Karuk, Yurok, Resighini Rancheria, Hoopa Valley, and Klamath, currently consume considerable amounts of fish and may ingest or contact water during fishing, bathing, collection and washing of basket and plant materials, and during tribal ceremonies such as the Boat Dance (DOI 2011) (see also Section 3.12.2.1 *Tribal Cultural Chronology and Ethnography (including Historic and Pre-Historic Periods – Northwest California Culture Area*). Under current conditions, seasonal blooms of nuisance blue-green algae regularly occur in Lower Klamath Project reservoirs and are released from Iron Gate and Copco No. 1 reservoirs into the Middle and Lower Klamath River. This can result in elevated concentrations of algal toxins in the water commonly exceeds public health advisory postings for water contact and inhibit the use of the Middle and Lower Klamath River for tribal purposes. Released blue-green algae can also clog fishing nets as well as result in elevated concentrations of algal toxins in the water, further interfering with tribal use of the river (see Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*).

Based on available data, measured concentrations of the algal toxin microcystin in fish tissue have varied in the Middle and Lower Klamath River, but instances of microcystin bioaccumulation have been reported at levels that exceed public health guidelines (in addition to the water column exceedances mentioned above) (see Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project – Algal Toxins*). Because of health risks associated with direct ingestion of fish tissue and water, as well secondary health risks due to dermal exposure to water containing elevated levels of algal toxins, tribes have had to adopt precautionary steps to avoid ingestion and water contact (DOI 2011).

Despite the slightly increased total nutrient concentrations anticipated under the Proposed Project in the Hydroelectric Reach (see Potential Impact 3.2-8), elimination of the reservoir environment that currently supports growth conditions for toxin-producing nuisance blue-green algal species such as *Microcystis aeruginosa* would result in decreases in high seasonal concentrations of chlorophyll-*a* (greater than 10 ug/L) and periodically high levels of algal toxins (greater than 8 ug/L microcystin) generated by suspended blue-green algae in the Hydroelectric Reach, the Middle and Lower Klamath River as well as the Klamath River Estuary (see Potential Impact 3.2-12). The anticipated reductions in blue-green algae concentrations under the Proposed Project would support Cultural Use of Klamath River waters without risk of adverse health effects, which would improve tribal members' access to the river above levels occurring under existing conditions. This would be a beneficial effect. Since drawdown of the reservoirs would begin in winter and would be largely complete by March/April (i.e., the beginning of the algal growth season) of dam removal year 2, reductions in chlorophyll-*a* and algal toxins would be a short-term benefit as well as a long-term benefit since the reduction would begin during dam removal year 2 and it would continue beyond post-dam removal year 1 (Potential Impact 3.2-12).

Significance

Beneficial in the short term and long term

3.12.5.2 Potential Impacts to Built Environment and Historic-period archaeological Resources

Potential Impact 3.12-11 Facilities removal would result in significant impacts to Copco No. 1 Dam, Copco No. 2 Dam, and Iron Gate Dam, their associated hydroelectric facilities, and the Klamath River Hydroelectric Project District as a whole.

The Proposed Project would include removal of large-scale contributing elements of the Klamath River Hydroelectric Project District, an historical resource recommended eligible for listing to the California Register of Historical Resources for the role in early development of electricity and economy of the southern Oregon and northern California regions (Cardno Entrix 2012; Kramer 2003a,b).

Under the Proposed Project, J.C. Boyle Dam, Copco No. 1 Dam, Copco No. 2 Dam, and Iron Gate Dam, and many of the associated hydroelectric facilities would be removed. (see Section 2 *Proposed Project*) Proposed Project activities would directly impact the historical significance of the dam structures and hydroelectric facilities and other associated properties. Removal of the three California dams (the major contributors of significance), would preclude the ability for the district to remain eligible for listing with the California Register of Historical Resources. Thus, facilities removal would be a significant impact on the resource.

As the core of the Proposed Project is removal of the Lower Klamath Project dams and associated facilities, historical restoration and "adaptive re-use" is simply not feasible as mitigation for these facilities. Dams and other hydroelectric facilities are not able to be relocated, making this form of mitigation not feasible. Maintaining some structures in place is considered in Section 4.3 *Partial Removal Alternative*.

Documentation measures that meet the National Park Services Secretary of the Interior standards for documentation of historical architectural and engineering properties are the only feasible form of mitigation because avoidance and minimization measures would not be possible.

The Proposed Project includes a Cultural Resources Plan (Appendix B: *Definite Plan – Appendix L*) that considers potential impacts to historic built environment resources, including the Klamath River Hydroelectric Project District. The Cultural Resources Plan proposes updating the Request for Determination of Eligibility for listing on the NRHP to include Iron Gate Dam (which has reached 50 years of age since the Request was first filed. Additionally, the Cultural Resources Plan sets forth a process for addressing potential impacts through avoidance and preservation in place as a first priority, then minimization, then resource-specific approaches where avoidance and minimization are not feasible. Where documentation is used, the Cultural Resources Plan recommends adopting protocols consistent with the Secretary of the Interior's Standards for Archaeological Documentation, Historical Documentation, and Architectural and Engineering Documentation; the ACHP Section 106 Archaeology Guidance; and other guidance from the appropriate SHPOs and/or THPOs, as applicable.

However, elements of the Cultural Resources Plan are not final. The Cultural Resources Plan would be further developed by KRRC working through the FERC process to comply with Section 106 of the National Historic Preservation Act of 1966, as codified in 36 CFR Part 800. As stated in the Cultural Resources Plan, mitigation measures and other protective measures would be developed and implemented to protect historic built environment resources.

Overseeing development and implementation of the Cultural Resources Plan does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has initiated a process through the Cultural Resources Working Group and FERC to develop a Historic Properties Management Plan and a Programmatic Agreement that will be finalized and implemented, at this time the Historic Properties Management Plan and the Programmatic Agreement are not finalized and the State Water Board cannot require their implementation. While the State Water Board anticipates that implementation of the Historic Properties Management Plan and the Programmatic Agreement would reduce impacts to the historical built environment, the core of the Proposed Project is removal the hydroelectric facilities and much of the context for these historic resources, such that historical restoration, "adaptive re-use," or relocation of the structures and buildings is not feasible. Even with documentation, the impact to the resource and its context would be significant and the historic resource would be materially impaired. Thus, while the inclusion of documentation measures in conformance with the Secretary of the Interior's guidance would lessen the impact to the resource, the impact to the Klamath Hydroelectric Historical District under the Proposed

Project would be significant and unavoidable even with inclusion of the KRRC's proposed mitigation measure.

Significance

Significant and unavoidable

Potential Impact 3.12-12 Pre-dam-removal activities that involve disturbance of the landscape, including construction or improvement of associated roads, bridges, water supply lines, staging areas, disposal sites, hatchery modifications, recreation site removal and/or development, and culvert construction and improvements could result in potential exposure of or damage to historic-period archaeological resources (identified in Table 3.12-1) through ground-disturbing construction and disposal activity and increased access to sensitive areas.

Historic-period cultural resources are known to be present within Area of Analysis *Subarea 1* (Figure 3.12-2) and are identified in Table 3.12-1. Pre-dam removal activities involving ground disturbance, construction or improvement of associated roads, bridges, water supply lines, staging areas, disposal sites, hatchery modifications, recreation site removal and/or development, and culvert construction and/or improvements would occur within the Area of Analysis *Subarea 1* (Figure 3.12-2).

Due to the nature of ground-disturbing activities and a general increase in the level of activity (e.g., construction, surveys) within the Area of Analysis *Subarea 1*, pre-dam removal activities that would involve ground disturbance have the potential to result in the following impacts to historic-period cultural resources through physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings; and/or exposure or substantial movement of the resources leading to increased illicit looting resulting in a significant impact.

To reduce impacts to historic-period cultural resources associated with pre-dam removal activities, the KRRC is developing a Historic Properties Management Plan to identify historic properties and include measures to implement before and during drawdown and dam removal activities to protect significant historic, cultural, and tribal resources during Proposed Project implementation. The Historic Properties Management Plan will be submitted to FERC for approval before the commencement of any ground disturbing activities (including reservoir drawdown).

Additionally, the KRRC has committed to implement a Looting and Vandalism Prevention Program (LVPP) to reduce looting and vandalism to TCRs and historic-period cultural resources (Mitigation Measure TCR-2), and an Inadvertent Discovery Plan (IDP) that would include actions to implement in the event an inadvertent discovery (e.g., human remains) (Mitigation Measure TCR-3), both of which would provide for compliance with applicable laws regarding cultural resources and human burials.

Implementation of the Historic Properties Management Plan, Mitigation Measure TCR-2 (LVPP), and Mitigation Measure TCR-3 (IDP) would reduce these impacts considerably, and, for many resources is expected to avoid impacts completely through the design and implementation of construction plans or on-the-ground modifications to Proposed Project implementation. For impacts for which it is not feasible to completely avoid, these impacts may be reduced to a less than significant level with implementation of the Historic Properties Management Plan, Mitigation Measure TCR-2 (LVPP), and Mitigation Measure TCR-3 (IDP).

Overseeing development and implementation of the Historic Properties Management Plan does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has initiated a process through the Cultural Resources Working Group and FERC to develop the Historic Properties Management Plan and a Programmatic Agreement that will be finalized and implemented, at this time the Historic Properties Management Plan and the Programmatic Agreement are not finalized and the State Water Board cannot require their implementation. While the State Water Board anticipates that implementation of the Historic Properties Management Plan and the Programmatic Agreement, including any modifications developed through the FERC process that provide the same or better level of protection for historic-period cultural resources, would reduce impacts to less than significant, because the State Water Board cannot ensure implementation of the Historic Properties Management Plan and the Programmatic Agreement, it is analyzing the impact in this Draft EIR as significant and unavoidable.

Significance
Significant and unavoidable impact with mitigation

Potential Impact 3.12-13 Drawdown of Iron Gate, Copco No. 1, and Copco No. 2 reservoirs could shift, erode, or exposure historic-period archaeological resources resulting in increased potential for damage and looting.
The Proposed Project would draw down Iron Gate, Copco No.1, Copco No. 2 and J.C. Boyle reservoirs at a rate between 2 and 5 feet per day (i.e., 1 to 2.5 inches per hour). Drawdown of Copco No. 1 would begin November 1 of dam removal year 1 at a maximum rate of 2 feet per day, and drawdown of all reservoirs would occur at a maximum rate of 5 feet per day beginning January 1 of dam removal year 2 and continue until March 15 of the same year. The analysis for this potential impact focuses on the California Lower Klamath Project reservoirs, including Copco No. 1, Copco No. 2, and Iron Gate, which are contained within Area of Analysis *Subarea 1* (Figure 3.12-2).

Since construction of Lower Klamath Project reservoirs, fine sediments composed primarily of organic material (including dead algae), but also including some silts and clays, have accumulated on the reservoir bottoms covering the original topography and potentially historic-period cultural resources that were present prior to reservoir construction. The distribution of sediment deposits associated with sediment deposition following reservoir construction varies within each reservoir (Figures 2.7-8 and 2.7-9). Because the accumulated sediments are primarily fine material, they will be easily eroded and flushed out of the reservoirs into the Klamath River during reservoir drawdown. The degree of sediment erosion will vary, with the majority of the erosion focused in the former river channel that is currently submerged in Copco No. 1, Copco No. 2, and Iron Gate reservoirs (see Figures 2.7-5 and 2.7-6). The Proposed Project also includes barge-mounted pressure spraying during reservoir drawdown that would target six locations in Copco No. 1 Reservoir and three locations in Iron Gate Reservoir within which to maximize erosion of sediment deposits and subsequently excavate to the historical floodplain elevation to create wetlands, floodplain areas and off-channel habitat features (see Appendix B: *Definite Plan – Appendix H Figures 5-4 and 5-7*).

Following drawdown, approximately 40 to 60 percent of the sediment deposited since construction of Lower Klamath Project reservoirs would remain in the former reservoir footprints, primarily on terraces located above the historical river channel. The sediments that remain in the reservoir footprints would consolidate (dry out and decrease in thickness) (USBR 2012a), likely making them less subject to erosion. Further, during reservoir drawdown, aerial seeding of pioneer seed mixes would occur following the receding reservoir waters. Aerial seeding during reservoir drawdown would not result in any further disturbance of soil on the exposed reservoir terraces and the establishment of vegetation on the terraces would potentially reduce erosion of fine sediments. Recent laboratory tests of reservoir sediments showed vegetated sediments produced less erodible fine particles and aggregates during cycles of wetting and drying than unvegetated sediments (Appendix B: *Definite Plan – Appendix H*).

Although not currently anticipated by KRRC, the Proposed Project may also include hydroseeding from a barge on exposed reservoir terraces as the water recedes during reservoir drawdown. Hydroseeding from a barge would be accomplished by placing a ground rig on one barge with another boat used to ferry materials from shore. A moveable pier or other engineered method of accessing the supply boat as the water level recedes would also be needed. If it occurs, barge hydroseeding would occur in the higher elevation portion of the reservoir shoreline, until the reservoir levels become too low to operate (i.e., March of dam removal year 2). If barge hydroseeding occurred, additional disturbances of reservoir sediments would occur as wave action from the barge would increase disturbance of sediment adjacent to the receding reservoir's shoreline, potential increasing the chance for slope instability and exposure of historic-period archaeological resources.

Historic-period cultural resources associated with late-nineteenth and early-twentieth century settlement, agriculture, logging, mining, hydroelectric, and transportation facilities are known to be present within the proposed Limits of Work (Area of Analysis *Subarea 1)* (Figure 3.12-2). Known historic-period archaeological sites along the margin of Copco Reservoir include ruins of buildings (P-47-002824) and refuse dumps (P-47-003917 and P-47-003922). Other known but unrecorded historic period sites at Copco Reservoir included early homesteads[157], such as the lands of Ward, Keeton, Reimundo, and Pecard (Daniels 2017), and Spannaus, Lennox and Kempler. Additionally, there are references to railroads, irrigation ditches, buildings, camps, roads, trails, bridges, and agricultural fields in the historic record that are not attributed to a specific location but could be encountered during Copco Reservoir drawdown (see Appendix B: *Definite Plan – Appendix L, Table 6-12*)

Known historic-period cultural resources along the shoreline of Iron Gate Reservoir include a homestead site (P-47-003940), several stacked rock wall segments (P-47-003943, P-47-003942, and P-47-003937), and a location with dozens of historical rock cairns believed to be the result of field clearing (P-47-003945) (Cardno ENTRIX 2012, PacifiCorp 2004). Additionally, there are references to homesteads of Griever, Madero, and Spearing, rock walls, irrigation ditches, bridges, road trails, railroads, former gauge stations that could be encountered during Iron Reservoir drawdown.

Specific historic-period cultural resources located at the sites identified above include features, such as buildings, foundations, cellars, wood posts, rock stacks, refuse deposits, wells, privies, and orchards. Associated artifacts may include whole of fragmented glass or ceramic containers, table ware, lighting, or electrical artifacts. Metal

[157] Some historic-period resources may also be considered Tribal Cultural Resources and are included in Potential Impacts 3.12-1 through 3.12-10.

artifacts may include fencing, wire, containers, fasteners, tools, and roofing. Other structural and personal artifacts may include brick or mortar, wood, rubber, some plastics, and textiles. These archaeological materials can be discovered in concentrations, such as in a refuse dump, or as isolated artifacts.

The condition of historic-period cultural resources inundated under the reservoirs is unknown, however it is anticipated that deposits of artifacts, features and sites are present and could be impacted from shifting and erosion of reservoir sediment deposits during and after drawdown. Some historic-period cultural resources within the reservoir footprints may remain covered in sediment, or capped, resulting in some degree of preservation and disturbance minimization.

Due to the nature of ground-disturbing activities during drawdown within the Area of Analysis *Subarea 1* that have the potential to result in physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings; and/or exposure or substantial movement of the resources leading to increased illicit looting, the impact of drawdown to historic-period cultural resources would result in a significant impact. However, as discussed in Potential Impact 3.12-2, the KRRC is developing a Historic Properties Management Plan, LVPP, and IDP to identify historic properties and include measures to implement before and during drawdown and dam removal activities to protect historic, cultural, and tribal resources. Implementation of the Historic Properties Management Plan, Mitigation Measure TCR-2 (LVPP), and Mitigation Measure TCR-3 (IDP) would reduce significant drawdown impacts considerably, and, for many resources is expected to avoid impacts completely through the design and implementation of construction plans or on-the-ground modifications to Proposed Project implementation. For impacts that it is not feasible to completely avoid, the impacts may be reduced to a less than significant level with implementation of the Historic Properties Management Plan, Mitigation Measure TCR-2 (LVPP), and Mitigation Measure TCR-3 (IDP).

Overseeing development and implementation of the Historic Properties Management Plan does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has initiated a process through the Cultural Resources Working Group and FERC to develop the Historic Properties Management Plan and a Programmatic Agreement that will be finalized and implemented, at this time the Historic Properties Management Plan and the Programmatic Agreement are not finalized and the State Water Board cannot require their implementation. While the State Water Board anticipates that implementation of the Historic Properties Management Plan and the Programmatic Agreement, including any modifications developed through the FERC process that provide the same or better level of protection for historic-period cultural resources, would reduce impacts to less than significant, because the State Water Board cannot ensure implementation of the Historic Properties Management Plan and the Programmatic Agreement, it is analyzing the impact in this Draft EIR as significant and unavoidable.

Significance

Significant and unavoidable with mitigation

Potential Impact 3.12-14 Reservoir drawdown could result in short-term erosion or flood disturbance to historic-period cultural resources located along the Klamath River.

As discussed in Potential Impact 3.12-3, the proposed drawdown of the Lower Klamath Project reservoirs is designed to minimize potential flood risks, including carefully drawing down the reservoirs using controlled flow releases and the increased storage availability in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs once drawdown has begun to accommodate for potential winter flow events and drawdown would not result in flows that are out of the normal range of flows experienced under existing conditions.

Hydrologic and hydraulic modeling of floodplain inundation shows that removal of the Lower Klamath Project dams could result in minor alterations to the FEMA 100-year floodplain inundation area downstream of Iron Gate Dam, along the 18-river mile stretch of the Middle Klamath River between RM 193 and 174 (i.e., from Iron Gate Dam to Humbug Creek) (USBR 2012c). Changes in the extent of the floodplain inundation area could affect potential historic-period cultural resources currently located within the FEMA 100-year floodplain (P-47-00522 [Empire Quartz Mine], P-47-00536 [Klamathon Townsite and Limber Mill], P-47-003937 [Rock Wall], P-47-004212 [Bridge], and P-47-004427 [artifact scatters]) which could result in a significant impact to historic-period cultural resources.

As discussed in Potential Impact 3.12-11, the KRRC is developing a Historic Properties Management Plan and an IDP to identify historic properties and include measures to implement before and during drawdown and dam removal activities to protect historic, cultural, and tribal resources. Implementation of the Historic Properties Management Plan and Mitigation Measure TCR-3 (IDP) may reduce impacts to resources identified in the 18-river mile stretch below Iron Gate Dam but given their proximity to Iron Gate Dam and their future inclusion in the altered 100-year floodplain following completion of the Proposed Project, impacts would remain significant and unavoidable.

As implementation of the Proposed Project is not anticipated to result in any other changes to the FEMA 100-year floodplain, or result in drawdown flows above historically recorded flows, potential impacts to historic-period cultural resources along other portions of the Klamath River would result in no significant impact.

Significance

Significant and unavoidable with mitigation for Middle Klamath River from Iron Gate Dam (RM 193) to Humbug Creek (RM 174)

No significant impact for Hydroelectric Reach excluding Iron Gate Dam, Middle Klamath River downstream of Humbug Creek, Lower Klamath River, Klamath River Estuary

Potential Impact 3.12-15 Project activities associated with removal of Iron Gate, Copco No. 1, and Copco No. 2 dams could result in physical disturbance to historic-period cultural resources from blasting or other removal techniques.

As described in Potential Impact 3.12-4, blasting and other dam removal techniques could cause significant adverse impacts to historic-period cultural resources located in the immediate vicinity[158] of Iron Gate, Copco No.1 and Copco No. 2 dams. The direct

[158] For the purposes of this analysis, "immediate vicinity" is defined as within 0.25 miles of Copco No. 1, Copco No. 2, and Iron Gate dams.

physical disturbance associated with blasting and other removal techniques could significantly impact historic-period archaeological resources that directly overlap with the blasting locations.

Though no data has identified historic-period cultural resources in the immediate vicinity of Iron Gate, Copco No. 1, and Copco No. 2 dams, but given the use of lands surrounding Proposed Project dams prior to construction of the Lower Klamath Project, this potential impact analysis assumes that historic-period archeological resources may be present in the immediate vicinity. For historic-period cultural resources that may be present in the immediate vicinity, impacts to these resources associated with dam removal would be significant and unavoidable.

As discussed in Potential Impact 3.12-11, the KRRC is developing a Historic Properties Management Plan and an IDP to identify historic properties and include measures to implement before and during drawdown and dam removal activities to protect historic, cultural, and tribal resources. Implementation of the Historic Properties Management Plan and Mitigation Measure TCR-3 (IDP) may reduce impacts to resources in the immediate vicinity of Iron Gate, Copco No. 1, and Copco No. 2 dams, but given construction activities and their potential for impacts to potential historic-period cultural resources, impacts would remain significant and unavoidable.

Significance

Significant and unavoidable with mitigation

Potential Impact 3.12-16 Ground disturbance associated with reservoir restoration, recreation site removal and/or development, and disposal site restoration could physically disturb historic-period cultural resources. Additionally, ongoing road and recreation site maintenance may have the potential to disturb known historic-period cultural resources.

As discussed in Potential Impact 3.12-5, the Proposed Project includes a Reservoir Area Management Plan that includes restoration activities that would occur both within the reservoir footprint and in upland areas (i.e., disposal, staging, and hydropower infrastructure demolition areas, access roads, former recreational areas) within the Area of Analysis *Subarea 1* (Figure 3.12-2). Historic-period archaeological resources are located within the footprints of Lower Klamath Project reservoirs.

Ground-disturbing activities associated with ongoing road, restoration, and recreation site maintenance within the Area of Analysis *Subarea 1* (Figure 3.12-2) include grading and excavating, which may result in material impairment due to physical demolition, destruction, relocation, or alteration of historic-period cultural resources located in both upland and reservoir footprint locations resulting in a significant impact.

However, as discussed in Potential Impact 3.12-11, the KRRC is developing a Historic Properties Management Plan, LVPP, and IDP to identify historic properties and include measures to implement before and during drawdown and dam removal activities to protect historic, cultural, and tribal resources. Implementation of the Historic Properties Management Plan, Mitigation Measure TCR-2 (LVPP), and Mitigation Measure TCR-3 (IDP) would reduce significant post-dam removal restoration impacts considerably, and, for many resources is expected to avoid impacts completely, through the design and implementation of construction plans or on-the-ground modifications to Proposed Project implementation. For impacts that it is not feasible to completely avoid, the impacts may be reduced to a less than significant level with implementation of the Historic Properties Management Plan, Mitigation Measure TCR-2 (LVPP), and Mitigation Measure TCR-3 (IDP).

Overseeing development and implementation of the Historic Properties Management Plan does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has initiated a process through the Cultural Resources Working Group and FERC to develop the Historic Properties Management Plan and a Programmatic Agreement that will be finalized and implemented, at this time the Historic Properties Management Plan and the Programmatic Agreement are not finalized and the State Water Board cannot require their implementation. While the State Water Board anticipates that implementation of the Historic Properties Management Plan and the Programmatic Agreement, including any modifications developed through the FERC process that provide the same or better level of protection for historic-period cultural resources, would reduce impacts to less than significant, because the State Water Board cannot ensure implementation of the Historic Properties Management Plan and the Programmatic Agreement, it is analyzing the impact in this Draft EIR as significant and unavoidable.

Significance

Significant and unavoidable impact with mitigation

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3.13 Paleontologic Resources

This section of the EIR analyzes the potential impacts of the Proposed Project on paleontologic resources.

3.13.1 Area of Analysis

The Area of Analysis for paleontologic resources includes the region within and adjacent to the Klamath River 100-year floodplain, in Siskiyou, Humboldt, and Del Norte counties, from the Oregon-California state line to the Klamath River's mouth near Requa, CA (Figure 3.13-1).

The Area of Analysis is defined to be within 1,000 feet of the FEMA Flood Zones A and AE. For areas of the Klamath River that do not have FEMA Flood Zone designation, the Area of Analysis is defined to within 3,000 feet of the National Hydrography Dataset Klamath River centerline. For the area upstream of Iron Gate Dam, the Area of Analysis is defined to be within a five-mile buffer of the National Hydrography Dataset Klamath River centerline.

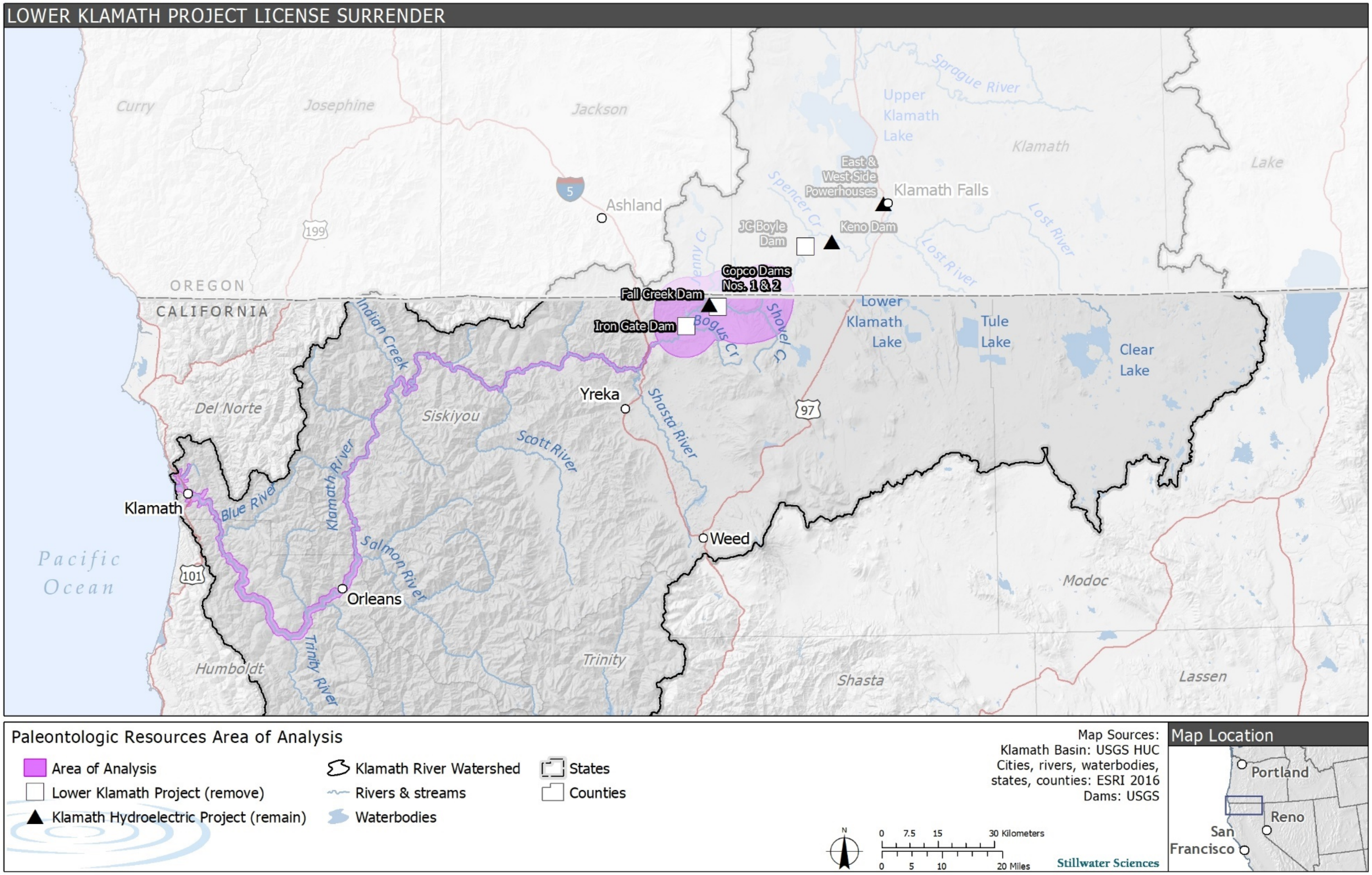

Figure 3.13-1. Area of Analysis for Paleontologic Resources.

3.13.2 Environmental Setting

The Klamath River passes through four main regional rock types that dominate the geology and which span the Mesozoic and Cenozoic eras. The four main rock types include metamorphic, igneous (volcanic), fluvial sedimentary, and marine sedimentary (Figure 3.11-2). Metamorphic rocks are rocks that have changed into different rock types due to changes in temperature and pressure. Sometimes rocks that have fossils in them become sufficiently metamorphosed that the fossils no longer exist. Igneous volcanic rocks are rocks that are formed as a process related to volcanic eruptions, so generally these types of rocks do not contain fossils. Though, sometimes volcanic deposits can entomb organisms during deposition, thus preserving these organisms which can later turn into fossils. Fluvial sedimentary rocks are rocks formed from river sediments. Marine sedimentary rocks are rocks formed from sediments in the ocean.

While the majority of bedrock deposits within the Area of Analysis for paleontologic resources are not fossil-bearing units, exceptions include an unnamed diatomite deposit along the shores of Copco No. 1 Reservoir and the Hornbrook Formation (USGS 1983, Elliot 1971). Additional details about the regional geologic framework are presented in Section 3.11.2.1 *Regional Geology*.

3.13.2.1 Bedrock Geology

The eastern portion of the Klamath Basin (the Cascade Range Geomorphic Province, approximately east of U.S. Interstate 5; Figure 3.11-1) is underlain by Tertiary and Quaternary volcanic rocks (Wagner and Saucedo 1987). These rocks generally do not contain fossils. To the west, in the Klamath Mountains and Coast Ranges Geomorphic Provinces, the Klamath Basin is underlain by Paleozoic and Mesozoic metasedimentary (metamorphic) and igneous rocks (Wagner and Saucedo 1987, Irwin 1994, Delattre and Rosinski 2012, Ernst 2015). The igneous rocks lack fossils and the metasedimentary rocks have been deformed sufficiently to destroy fossils; accordingly, no fossils have been documented in these rocks. There are also mapped Quaternary fluvial[159] deposits, discontinuously, along the entire Klamath River (Hotz 1967, 1977; Wagner and Saucedo 1987; Delattre and Rosinski 2012), as well as diatomite deposits along the banks of Copco No. 1 Reservoir (USGS 1983). While these fluvial deposits may contain fossils, no fossils have been documented to exist in the Area of Analysis for paleontologic resources.

The Late Cretaceous Hornbrook Formation (Hornbrook Formation) is mapped at the boundary between the Cascade Range and Klamath Mountains geomorphic provinces, 2 of California's 11 geomorphic provinces (Peck et al. 1956, Elliot 1971, Nilsen et al. 1983, Nilsen 1984, Sliter et al. 1984, Nilsen 1993, Irwin 1994, Nilsen 1994, Elliot 2007, Surpless 2015). The Cascade Range Geomorphic Province is the region from northern California into southwestern Canada where topographic forms are dominated by the volcanism associated with the Cascades volcanoes. The Klamath Mountains Geomorphic Province is a region in northwestern California and southwestern Oregon where the landforms and topography are controlled by uplifted ancient subduction zone and igneous (plutonic) rocks. Plutonic rocks are igneous rocks that formed beneath the surface of the Earth. Hornbrook Formation rocks are composed of marine and non-

[159] Quaternary refers to the Quaternary Period, a time range between 2.56 million years ago and extends to today. Fluvial refers to sediments deposited as a result of processes associated with rivers.

marine sedimentary rocks formed between 100 and 66 million years ago, but possibly as early as 113 million years ago (Surpless 2015). Nilsen et al. (1983), along with previous mappers, documented that many of the subunits within the Hornbrook Formation have fossils including mollusks, ammonites, foraminifers, plant fossils, and paleosols.

3.13.2.2 Paleontologic Resources

Two mapped geologic units that contain paleontologic resources are present within the Area of Analysis: (1) the unnamed diatomite deposit at Copco No. 1 Reservoir; and (2) the Hornbrook Formation. The diatomite deposit is determined to be of Low Paleontologic Potential because these fossil diatoms (algae): 1) do not occur in association with significant vertebrate fossils; 2) are not rare; and 3) it is not thought that the distribution of fossils and fossil species has a significant spatial variation. The fossils in the Hornbrook Formation are documented to include megafossils (e.g., Gastropoda) and microfossils (e.g., Foraminifera), but it is not known if the fossil abundance varies spatially within this geologic unit.

The Klamath River cuts across the Hornbrook Formation in the region of Hornbrook, California, along approximately three river miles (Figure 3.13-2). The different sub-units within the Hornbrook Formation are listed relative to Geologic Symbol (symbology on the map), Unit Description (rock type), and Fossil Description (absence/presence; fossil types) in Table 3.13-1. All Hornbrook Formation units are within the Area of Analysis for paleontologic resources, but some of these mapped units are separated from the active channel by Quaternary Alluvium. Many of the fossil sampling locations are along Blue Gulch and Klamathon Road, south of Hornbrook, California (Nilsen 1993). Fossil biostratigraphy[160] was used to provide age control for the stratigraphic correlation of geologic units in the region of Hornbrook, California, along with geologic units elsewhere in northern California (Sliter et al. 1984). Type sections (unique and identifiable sedimentary stratigraphic sections) for each sub-unit in the Hornbrook Formation are located outside of the Area of Analysis (Nilsen 1993).

[160] Fossil biostratigraphy is the ability to date the age of rock formations based on the presence of fossils.

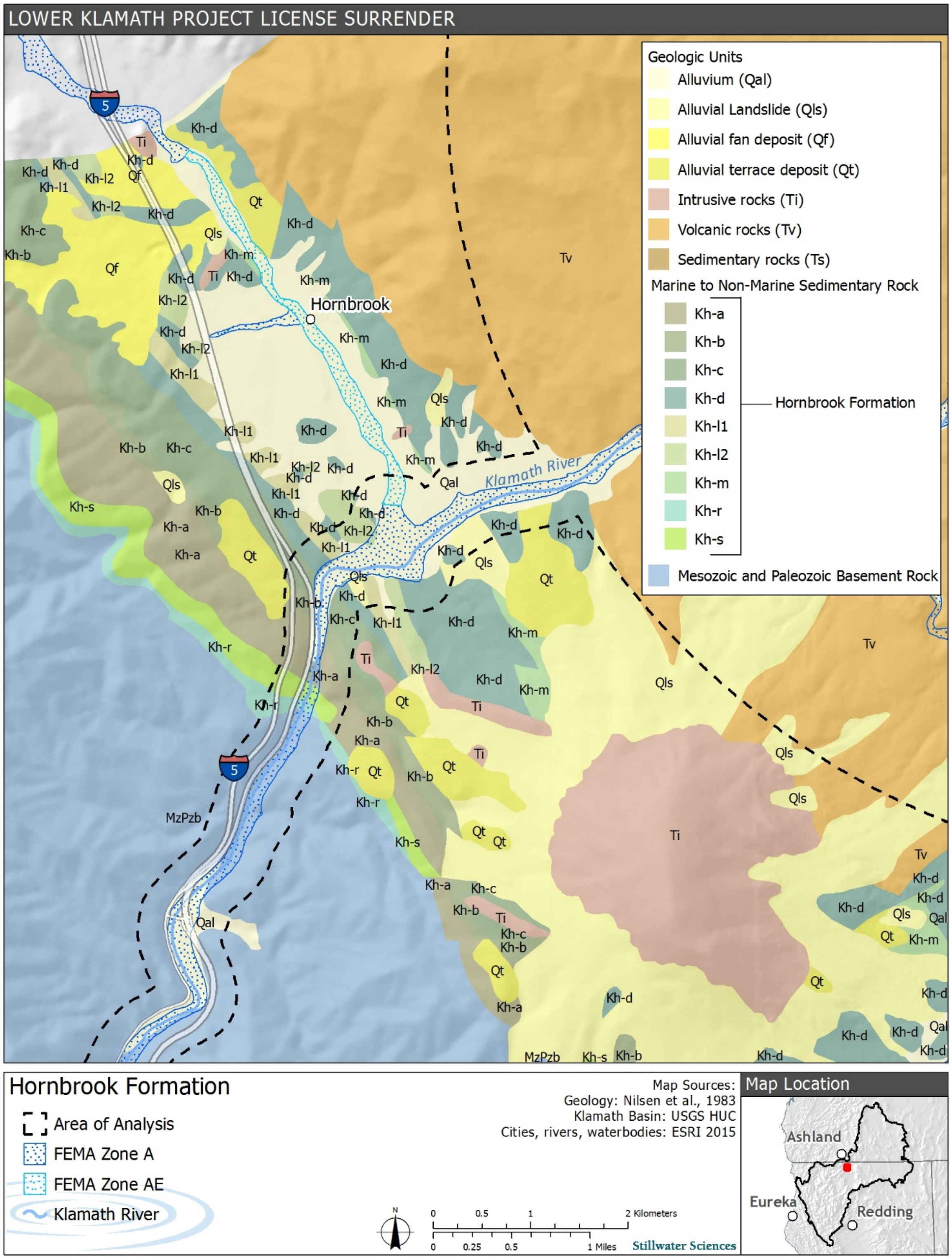

Figure 3.13-2. Late Cretaceous Hornbrook Formation mapped along the Klamath River (Nilsen et al. 1983). Hornbrook Formation unit descriptions are presented in Table 3.13-1.

The Hornbrook Formation is exposed in road cuts along Klamathon Road and the Old Hornbrook Highway in the region of Hornbrook, California. These outcrops include subunits IKh-d, Kh-l1, and Kh-l2.

Table 3.13-1. Hornbrook Formation Geologic Unit and Fossil Descriptions.

Geologic Symbol	Unit Description	Fossil Description
Kh-a	Marine Sandstone with local conglomerate; hummocky cross strata in upper part	Molluscan fossils
Kh-b	Marine siltstone with some mudstone and very fine-grained sandstone; local coal beds	Molluscan fossils
Kh-c	Marine sandstone and conglomerate with thin interbeds of shale	Unfossiliferous
Kh-d	Marine shale, mudstone, and thin-bedded, fine-grained sandstone	Ammonites and foraminifers
Kh-l1	Very fine- to fine-grained lens of hummocky cross stratified marine sandstone; lower unit	Molluscan fossils
Kh-l2	Very fine- to fine-grained lens of hummocky cross stratified marine sandstone; upper unit	Molluscan fossils
Kh-m	Thick bed of marine turbidite sandstone	—
Kh-r	Nonmarine conglomerate, sandstone, pebbly mudstone, and siltstone; locally a basal breccia	Plant fossils, paleosols
Kh-s	Marine conglomeratic sandstone characterized by large-scale trough cross strata	Molluscan fossils

3.13.3 Significance Criteria

Criteria for determining significant impacts on paleontologic resources are based upon Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and professional judgment. Effects on paleontologic resources are considered significant if the Proposed Project would:

- Result in the destruction of any High Potential Paleontologic Resources, as defined in Table 3.13-2 and discussed further below.
- Result in substantial adverse effects on any High Potential Paleontologic Resources, as defined further below.

In general, destruction of High Potential Paleontologic Resources includes the physical demolition, relocation, or alteration of the paleontologic resource that would alter or remove the factors that are the basis for determining the significance of the paleontologic resource. These factors include taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data uniquely related to the paleontologic resource. See definitions for, and an explanation of, these terms below.

In general, a substantial adverse effect on High Potential Paleontologic Resources is defined as a loss of fossils or their surrounding material contributing to the potential loss of taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic information. An explanation of each of these types of paleontologic information and the definition of substantial adverse effect specific to that type of information is provided below. While the below definitions are provided for examples of fossils from organisms' bodies, they also apply to trace fossils (fossils of a burrow, boring, feces, footprint, track, or some other physical evidence of life preserved in the rock record), as well as the material surrounding fossils and trace fossils.

- Taxonomic information includes the hierarchical classification of biological organisms (e.g., genus, species). A substantial adverse effect on taxonomic information would occur if rocks with fossils or their surrounding material that included significant taxonomic information were destroyed, such as fossils that had body parts with geometry that helped identify those species in a specific taxonomic way.
- Phylogenetic information describes how an extant species (one that no longer exists) may relate to other species in an evolutionary way (i.e., the "family tree" of the different species). A substantial adverse effect on phylogenetic information would occur if rocks with fossils or their surrounding material that included significant phylogenetic information were destroyed, such as fossils that have physical features that tie that species to other species in the "family tree" with the physical development of that species' physical form.
- Paleoecologic information inferred from the fossil related to the climate at time of deposition A substantial adverse effect on paleoecologic information would occur if rocks with fossils or their surrounding material that included significant paleoecologic information were destroyed, such as pollen, isotope, or other information that can be used as a proxy for the prehistoric climate.
- Taphonomic information describes how the organism(s) had been modified prior to fossilization (e.g., the erosion or modification of the shapes or forms of the pre-fossilized materials as they were transported in a landslide, tsunami, river flow or some other process). A substantial adverse effect on taphonomic information would occur if rocks with fossils or their surrounding material that included significant taphonomic information were destroyed, such as a fossil that had been modified by some physical process prior to fossilization, especially if that process is linked to some physical behavior of the organism or some physical process related to where the organism existed.
- Biochronologic information describes where fossils fit into the geologic time scale. A substantial adverse effect on biochronologic information would occur if rocks with fossils or their surrounding material that included significant biochronologic information were destroyed, such as if there is some chronologic information that linked the species with rocks of a particular age or age range.
- Stratigraphic information describes the layering of geologic materials with time, including information about superposition[161]). A substantial adverse impact on stratigraphic information would occur if rocks with fossils or their surrounding material that included significant stratigraphic information were destroyed, such as information about overlying or underlying geologic, biologic, or chemical data or trends in data.

[161] Superposition refers to a sedimentary deposit that is on top of another sedimentary deposit, the deposit on top is "superposed" over the lower sedimentary deposit. The superposed deposit is therefore younger than the underlying deposit.

3.13.4 Impacts Analysis Approach

Paleontologic resources are defined as any fossilized remains, traces, or imprints of organisms, preserved in or on the Earth's crust, that are of paleontologic interest and that provide information about the history of life on Earth. The Society of Vertebrate Paleontology published the “Standard Guidelines for the Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontological Resources” and this guide, updated in 2010, was developed to help evaluate the potential of destroying paleontologic resources during construction projects. These guidelines include an: “(a) assessment of the potential for land to contain significant paleontologic resources which could be directly or indirectly impacted, damaged, or destroyed by proposed development and (b) formulation and implementation of measures to mitigate these adverse impacts, including permanent preservation of the site and/or permanent preservation of salvaged fossils along with all contextual data in established institutions” (SVP 2010). These guidelines provide criteria for designating the potential paleontologic sensitivity of a site, along with the corresponding recommended mitigation measures required for high, moderate, or low potential for containing significant paleontologic resources (Table 3.13-2, SVP 2010).

Paleontologic potential consists of both: (a) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, plant, or trace fossils and (b) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data. Rock units that contain potentially datable organic remains older than late Holocene, including deposits associated with animal nests or middens, and rock units that may contain new vertebrate deposits, traces, or trackways are also classified as having high potential.

Significant nonrenewable paleontologic resources are fossils and fossiliferous deposits (rocks with fossils or fossil traces) here defined as consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information. Paleontologic resources are considered to be older than recorded human history and/or older than middle Holocene (i.e., older than about 5,000 radiocarbon years), as outlined in the Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources (SVP 2010). In other words, significant nonrenewable paleontologic resources include vertebrate fossils and their taphonomic and environmental indicators, along with invertebrate or botanical fossils in association with a vertebrate assemblage, or plant or invertebrate fossils that are defined as significant by a qualified vertebrate paleontologist[162]. In addition, if invertebrate, plant, or trace fossils are known to have an association with a significant vertebrate fossil

[162] Based on the SVP (2010), a qualified vertebrate paleontologist is a practicing scientist who is recognized in the paleontological community as a professional and can demonstrate familiarity and proficiency with paleontology in a stratigraphic context. A paleontological Principal Investigator shall have the equivalent of the following qualifications: (1) a graduate degree in paleontology or geology, and/or a publication record in peer reviewed journals; and demonstrated competence in field techniques, preparation, identification, curation, and reporting in the state or geologic province in which the project occurs. An advanced degree is less important than demonstrated competence and regional experience; (2) at least two full years professional experience as assistant to a Project Paleontologist with administration and project management experience; supported by a list of projects and referral contacts;(3) proficiency in recognizing fossils in the field and determining their significance; (4) expertise in local geology, stratigraphy, and biostratigraphy; and (5) experience collecting vertebrate fossils in the field.

and those invertebrate, plant, or trace fossils are present in a given rock, then there are potentially more of the significant fossil found in those rocks.

Of the various ways that nonrenewable paleontologic resources could be harmed, which includes excavation using heavy equipment, the fossil bearing geologic units in the Area of Analysis are exposed in regions that have exposure to river flows and could be harmed by erosion and undercutting. It is possible that river flows would be sufficiently large to erode the fossil bearing bedrock, undercutting this bedrock, leading to slope failure. If this were to happen, nonrenewable paleontologic resources could be harmed by the destruction of these outcrops through erosion and slope failure (landslides). Because the Hornbrook Formation is classified with a Low Paleontologic Potential, it was not evaluate further.

Table 3.13-2. Paleontologic Potential (SVP 2010).

Paleontologic Potential	Definition
High	Rock units from which vertebrate or significant invertebrate, plant, or trace fossils have been recovered are considered to have a high potential for containing additional significant paleontologic resources. Rocks units classified as having high potential for producing paleontologic resources include, but are not limited to, sedimentary formations and some volcaniclastic formations (e.g., ashes or tephras), and some low-grade metamorphic rocks which contain significant paleontologic resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils (e.g., middle Holocene and older, fine-grained fluvial sandstones, argillaceous and carbonate-rich paleosols, cross-bedded point bar sandstones, fine-grained marine sandstones, etc.). Paleontologic potential consists of both (a) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, plant, or trace fossils and (b) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data. Rock units which contain potentially datable organic remains older than late Holocene, including deposits associated with animal nests or middens, and rock units which may contain new vertebrate deposits, traces, or trackways are also classified as having high potential.
Undetermined	Rock units for which little information is available concerning their paleontologic content, geologic age, and depositional environment are considered to have undetermined potential. Further study is necessary to determine if these rock units have high or low potential to contain significant paleontologic resources. A field survey by a qualified professional paleontologist (see “definitions” section in this document) to specifically determine the paleontologic resource potential of these rock units is required before a paleontologic resource impact mitigation program can be developed. In cases where no subsurface data are available, paleontologic potential can sometimes be determined by strategically located excavations into subsurface stratigraphy.
Low	Reports in the paleontologic literature or field surveys by a qualified professional paleontologist may allow determination that some rock units have low potential for yielding significant fossils. Such rock units will be poorly represented by fossil specimens in institutional collections, or based on general scientific consensus only preserve fossils in rare circumstances and the presence of fossils is the exception not the rule, e.g., basalt flows or recent colluvium. Rock units with low potential typically will not require impact mitigation measures to protect fossils.
No	Some rock units have no potential to contain significant paleontologic resources, for instance high-grade metamorphic rocks (such as gneisses and schists) and plutonic igneous rocks (such as granites and diorites). Rock units with no potential require no protection nor impact mitigation measures relative to paleontologic resources.

The Paleontologic Potential was determined for each geologic unit within the paleontologic resources Area of Analysis using existing geologic and paleontologic peer review literature and data from the USGS, University of California Museum of Paleontology database (UCMP 2017), and geologic and paleontologic professional societies. Relevant geologic maps (Nilsen et al. 1983, Wagner and Saucedo 1987) were georeferenced and digitized, and a reconnaissance field survey was conducted on August 22, 2017 to evaluate the likelihood that mapped geologic units are exposed or otherwise could be impacted by the Proposed Project.

The following sources were assessed to determine the scope of existing local policies relevant to the Proposed Project:

- Siskiyou County General Plan (Siskiyou County 1980):
  - Land Use Policy 41.12 (Siskiyou County 1997)
  - The Conservation Element (Siskiyou County 1973), Archaeology, Objective F

The aforementioned policy (and objective) are stated in generalized terms, consistent with their overall intent to protect paleontologic resources. By focusing on the potential for impacts to paleontologic resources within the paleontologic resources Area of Analysis, consideration of the more general local policy listed above is inherently addressed by the specific, individual analyses presented in Section 3.13.5 *[Paleontologic Resources] Potential Impacts and Mitigation*.

3.13.5 Potential Impacts and Mitigation

Potential Impact 3.13-1 The Proposed Project could result in substantial adverse effects on, or destruction of, High Potential Paleontologic Resources through exposure or slope failure.

An on-site evaluation was conducted August 22, 2017, to evaluate the potential for exposure of paleontologic resources in the Area of Analysis. In the region of Hornbrook, CA, the Hornbrook Formation is exposed in road cuts along Klamathon Road and the Old Hornbrook Highway, in the form of partially lithified and fully lithified rock[163]. Based on observations of the Klamath River cutbank from the Old Hornbrook Highway and along Klamathon Road, the Hornbrook Formation bedrock is not presently exposed along the north bank of the Klamath River in this region. The banks of the river in this area are well vegetated and, downstream of the end of the Old Hornbrook Highway, they are armored by materials that form the road base for U.S. Interstate 5.

Under the Proposed Project, there are two scenarios that could result in erosion of the Hornbrook Formation along the Klamath River, which could impact paleontologic resources contained within the river banks. First, if as a result of dam removal, the river were to downcut (incise) upstream of the contact between the Mesozoic to Paleozoic bedrock and the Hornbrook Formation, this could lead to undercutting of the northern bank of the Klamath River and an over-steepened cutbank, possibly leading to erosion and slope failure within the Hornbrook Formation. Second, if as a result of dam removal, the Klamath River were to migrate laterally northwards on the outer bend of the river just south of Hornbrook (the same region discussed in the first scenario), the lateral migration could also possibly result in erosion and slope failure of the Hornbrook

[163] Lithified means the material has transformed from sediment to sedimentary rock.

Formation. However, the base level (e.g., the lowest level to that erosion can happen due to running water) of the river in the region of Hornbrook is controlled downstream by Mesozoic to Paleozoic basement rock and this base level control pre-dated the installation of any dams, including the Lower Klamath Project, on the Klamath River.

The evaluation of river flow rates, and the potential for bank erosion during drawdown downstream of the Lower Klamath Project dams, is documented in the geology (Potential Impact 3.11-6) and flood hydrology sections (Section 3.6.5 *[Flood Hydrology] Potential Impacts and Mitigation*). The KBRA expired on December 31, 2015 due to a lack of Congressional authorization, and the 2016 Amended KHSA, under which dam removal is currently proposed, does not involve a connected action. Consequently, this CEQA analysis considers the potential effects of dam removal using Klamath River flows as defined by the NMFS and USFWS 2013 Joint Biological Opinion (2013 BiOp) (NMFS and USFWS 2013a), which is currently the standard to which the USBR Klamath Irrigation Project operates. The 2013 BiOp operations requirements and court-ordered flushing flows would determine how instream flows through the Lower Klamath Project and releases from Iron Gate Dam are managed (NMFS and USFWS 2013, U.S. District Court 2017c). A summary of the hydrology information used in this EIR is provided in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* and potential impacts of reservoir drawdown on flood hydrology is addressed in Section 3.6.5 *[Flood Hydrology] Potential Impacts and Mitigation*. The proposed drawdown rates for each of the four dams are similar in magnitude to historical flow rates and discharge statistics for these reservoirs. Flow rates downstream of the dams are not anticipated to exceed substantially median historical rates. In other words, discharges during drawdown would be similar to, or less than, the seasonal 10-year flood rates of discharge.

Based on the analysis of Potential Impact 3.11-6, there could be bank erosion and slope failures in the lower river, but the magnitude of this bank erosion will not be substantial given that the flow rates will be similar or lower than flow rates during the operation of the Lower Klamath Project dams. Thus, there is a low likelihood that changes to river discharge under the Proposed Project would lead to downcutting or erosion of the Hornbrook Formation to a greater degree than existed prior to the construction of facilities associated with the creation of the Lower Klamath Project.

The different sub-units of the Hornbrook Formation are mapped in continuous to discontinuous regions surrounding and beyond the Area of Analysis for paleontologic resources. The fossils mapped by previous researchers were found in regions within and outside the Area of Analysis (Peck et al. 1956, Nilsen et al. 1983, Sliter et al. 1984), but fossils used at type sections[164] to correlate geologic units in the Hornbrook Formation are mapped outside of the Area of Analysis. The fossils contained within the Hornbrook Formation are not vertebrates nor do they contain significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data. While there have been identified plant fossils in some Hornbrook Formation subunits, they are not considered to be associated stratigraphically within a given vertebrate assemblage. Considering these factors, the Hornbrook Formation is interpreted to be of Low Paleontologic Potential.

[164] Type sections as defined in Section 3.13.2.2 *Paleontologic Resources*

Overall, given that there is a low likelihood that changes to river discharge under the Proposed Project would lead to additional downcutting or erosion of the Hornbrook Formation and the formation's Low Paleontologic Potential, there would be no impact to paleontologic resources due to implementation of the Proposed Project.

Significance

No significant impact

3.13.6 References

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3.14 Land Use and Planning

This section discusses the environmental setting for land use and planning, as well as potential environmental impacts and associated mitigation measures for the Proposed Project. This section does not address the potential effects of removal of the three California Lower Klamath Project dams on property values or changes in property tax revenues. The State Water Board received several comments expressing concerns about economic and property value changes; these issues are further addressed in Section 5.4 *Social and Economic Factors Under CEQA*. CEQA Guidelines Section 15064 (e) states that *"Economic and social changes resulting from a project shall not be treated as significant effects on the environment. Economic or social changes may be used, however, to determine that a physical change shall be regarded as a significant effect on the environment. Where a physical change is caused by economic or social effects of a project, the physical change may be regarded as a significant effect in the same manner as any other physical change resulting from the project"*. Further summary of comments related to land use issues received during the NOP public scoping process, as well as the individual comments themselves, is included in Appendix A.

Section 3.15 *Agriculture and Forestry Resources* focuses on the potential direct changes to agricultural and forestry that would occur as a result of the removal of Copco No. 1 Dam, Copco No. 2 Dam, and Iron Gate Dam. Section 3.15 describes Siskiyou County's agricultural and forestry land uses, identifies the acreages of agricultural and forestry land in Siskiyou County, and describes the factors contributing to changes in irrigated agricultural land and to forestry resources in the County. Section 3.21 *Hazards and Hazardous Materials* describes the potential impacts to wildfire suppression associated with removal of the Lower Klamath Project facilities. Forest vegetation communities and the potential effects of the Proposed Project on wildlife associated with these communities are discussed in Section 3.5 *Terrestrial Resources*. Additionally, the removal of the dams may alter the flood regime for a portion of the river downstream from Iron Gate Dam. Potential changes in flood risk under the Proposed Project are described in Section 3.6 *Flood Hydrology*.

3.14.1 Area of Analysis

The Area of Analysis for land use and planning includes California lands within the Project Boundary (Figure 3.14-1). This area includes Parcel B lands within California, as well as California lands that are within the proposed Limits of Work but not within Parcel B lands (i.e., Fall Creek Hatchery area, small portions of the Iron Gate Reservoir footprint, Jenny Creek Bridge).

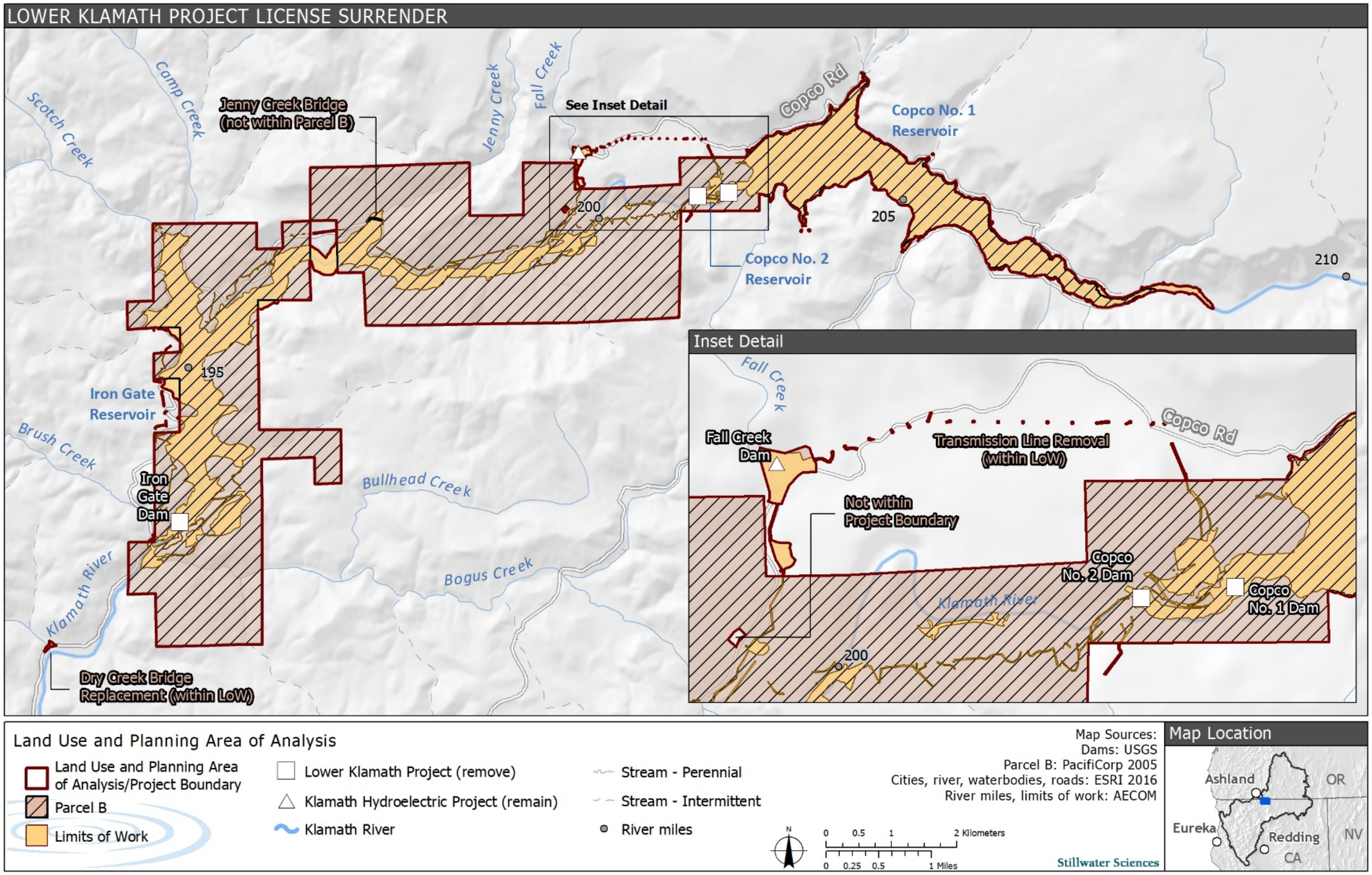

Figure 3.14-1. Land Use and Planning Area of Analysis.

3.14.2 Environmental Setting

3.14.2.1 Land Ownership

The Area of Analysis for land use and planning contains approximately 7,176.5 acres of submerged and non-submerged lands, which includes Parcel B lands owned by PacifiCorp that encompass most of the Copco No. 1, Copco No. 2, and Iron Gate reservoir footprints and adjacent areas of the dams, powerhouses, ancillary facilities, fish hatcheries, recreation areas, and certain transmission lines and access roads. Approximately 2,299 acres of the Area of Analysis (also the Project Boundary) are within the proposed Limits of Work (Figure 3.14-2), which include the areas identified as construction/demolition and staging areas in the immediate vicinity of Copco No. 1, Copco No. 2, and Iron Gate dams and reservoirs, and as well as other identified construction areas for the Iron Gate and Fall Creek hatchery modifications (see also Section 2.7.6 *Hatchery Operations*) and the City of Yreka water supply pipeline (see also Section 2.7.7 *City of Yreka Water Supply Pipeline Relocation*).

Table 3.14-1. Land Ownership in Acres within the Area of Analysis for Land Use and Planning.

Project Feature	BLM[1]	PacifiCorp Parcel A[1]	PacifiCorp Parcel B[1]	Other Private	Total (ac)
California portion of the Project Boundary (equivalent to the Area of Analysis)	59.3	21.8	7,013.1	82.3	7,176.5
California portion of the proposed Limits of Work	59.3	21.8	2,135.6	82.3	2,299.0

[1] Small adjustments were made to the boundaries of the BLM dataset to alleviate overlap with the PacifiCorp Parcel B dataset.

PacifiCorp Lands

PacifiCorp owns the majority of the land (7,034.9 acres) within the Area of Analysis for land use and planning (Table 3.14-1). Of this total, 2,157.4 acres are within the California portion of the proposed Limits of Work. Upon transfer of FERC License No. 14803 from PacifiCorp to the KRRC, the KRRC would take ownership of Parcel B lands. Per the KHSA Section 7.6.4, the KRRC will transfer ownership of Parcel B lands to the respective States or to a designated third-party entity following completion of the Proposed Project (Section 2.7.10 *Land Disposition and Transfer*).

U.S. Bureau of Land Management

The U.S. Bureau of Land Management (BLM) manages Mallard Cove Recreation Area at Copco No. 1 Reservoir, and several BLM parcels are crossed by transmission lines and Copco Road at Iron Gate Reservoir. In total, BLM manages 59.3 acres within the Area of Analysis for land use and planning.

Private Lands

Most of the land surrounding Copco No. 1 Reservoir is privately owned. Other smaller areas of privately-owned land are located adjacent to Iron Gate Dam and Fall Creek Dam. In total 82.3 acres of private lands are located within the Area of Analysis for land use and planning.

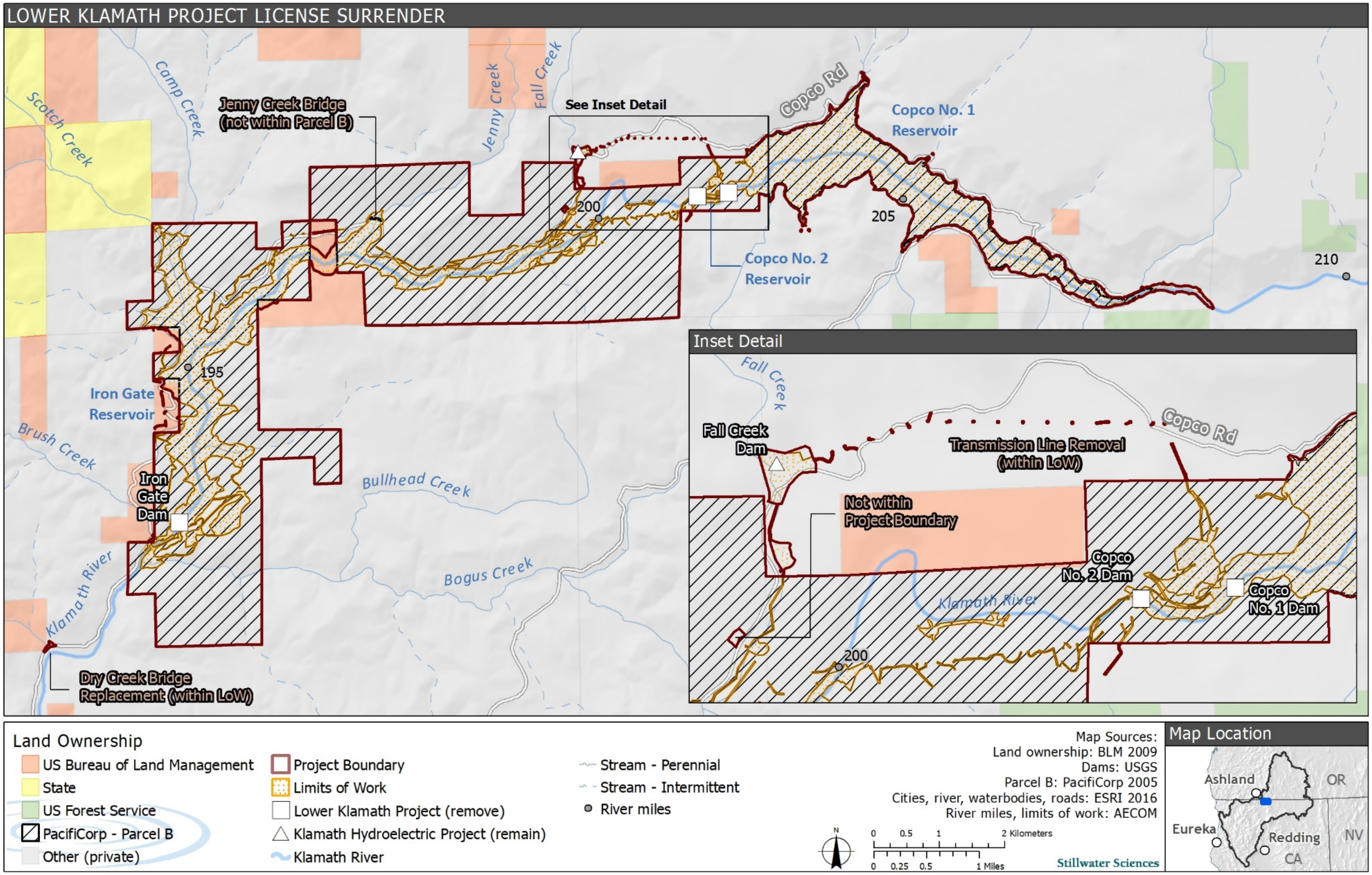

Figure 3.14-2. Surrounding Land Ownership.

3.14.2.2 Land Uses

The Area of Analysis for land use and planning is located within Siskiyou County. Figure 3.14-3 portrays the existing land uses by zoning classification within the Area of Analysis for land use and planning. Land uses within the Area of Analysis are designated by the county using the following generalized categories: Agriculture – Grazing, Forestry Resources, Open Space – Natural Resources, Rural Residential, and Commercial – Services, with many parcels currently vacant. The closest urban area is the City of Yreka, 20 miles to the southwest. Most of the land in the Area of Analysis is devoted either to agriculture/grazing or to open space and conservation of natural resources. A small portion is devoted to hydroelectric operations and recreation sites. There are residential developments on private parcels adjacent to Copco No. 1 Reservoir and the Klamath River throughout the Area of Analysis for land use and planning.

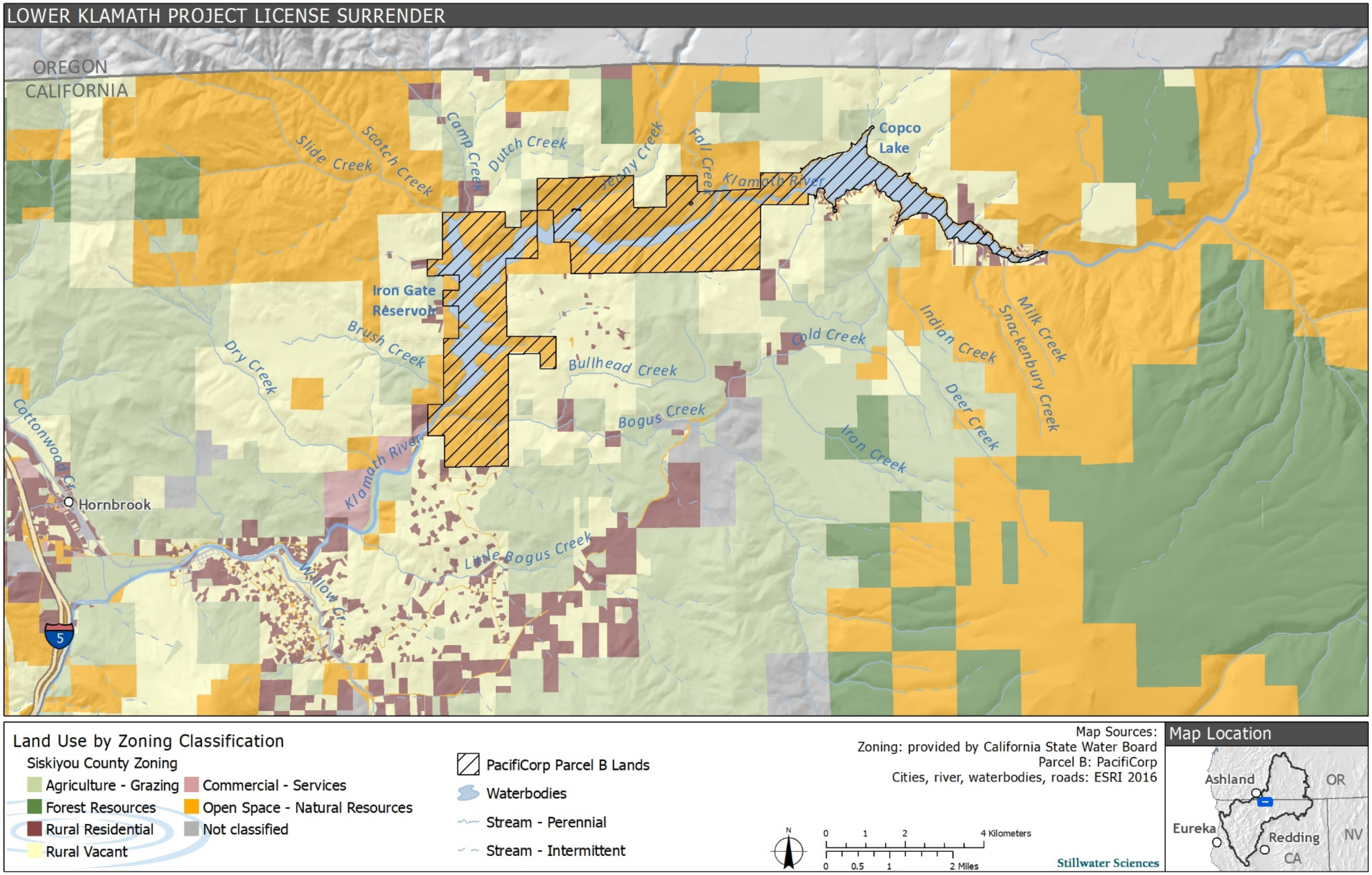

Figure 3.14-3. Siskiyou County Land Use by Zoning Classification.

Open Space/Recreation/Public Lands

Federal and state agencies own and/or manage public lands in the Area of Analysis for land use and planning. These include public lands primarily managed by BLM and USDA Forest Service. These areas are used for public recreation and open space, as well as forest and mineral resources. Other privately-owned recreation facilities (e.g., recreational vehicle parks) operate along the Klamath River downstream from Iron Gate Dam (see also Section 3.20 *Recreation*).

The majority of the Area of Analysis for land use and planning is categorized as Open Space – Natural Resources under the Siskiyou County Zoning Ordinance, which includes recreation and public lands. In general, these are undeveloped lands not in active use and include timber production, grazing land, and developed and dispersed recreational uses (see also Section 3.15 *Agriculture and Forestry Resources* and Section 3.20 *Recreation*).

Residential/Developed

In the Area of Analysis for land use and planning, there are residential developments along portions of the Copco No. 1 Reservoir. These developments are mostly low-density rural residential (R-R). Zoning is one unit per acre per County Zoning Ordinance Table 10-6.5501. The residential properties within the Area of Analysis are located primarily along the southern and northeastern Klamath River shorelines, along Ager-Beswick Road and Copco Road, respectively. Many parcels are vacant and undeveloped. There are residential subdivided areas (mostly vacant) south and east of Iron Gate Dam and additional residential lands along the Klamath River downstream of Iron Gate Dam. Residents typically have the ability to access the Lower Klamath Project reservoirs for boat travel and recreational uses.

Inundated Lands

Lands currently inundated by the reservoirs in Siskiyou County have land use designations and zoning that correspond with the adjacent lands (generally Open Space – Natural Resources, Agriculture-Grazing, and Rural Vacant). The reservoirs are utilized for open space/recreational uses.

Commercial/Industrial

The three California Lower Klamath Project dam facilities, which are considered commercial-industrial from a land-use perspective, are summarized in Section 2.3.2 *Copco No. 1 Dam and Associated Facilities,* Section 2.3.3 *Copco No. 2 Dam and Associated Facilities*, and Section 2.3.4 *Iron Gate and Associated Facilities*. Additional details are included in Appendix B: *Definite Plan*.

Existing Infrastructure

Existing infrastructure potentially affected by the Proposed Project within the Area of Analysis includes the City of Yreka water supply pipeline, existing domestic wells, recreation sites and facilities, and roads. Details regarding the City of Yreka water supply are presented in Section 2.7.7 *City of Yreka Water Supply Pipeline Relocation* and Section 3.8 *Water Supply/Water Rights*. Additional information on private wells can be found in Section 3.7 *Groundwater*. Utilities are described in both Section 3.17 *Public Services* and Section 3.18 *Utilities and Service Systems*. Recreation facilities are described in Section 3.20 *Recreation*. The existing roads in the land use and planning Area of Analysis are owned by PacifiCorp, the Federal Government, Siskiyou County or private entities, details of which can be found in Section 3.22 *Traffic and Transportation*.

PacifiCorp is responsible for maintaining approximately 14.5 miles of roads within the Area of Analysis.

3.14.3 Significance Criteria

Criteria for determining significance on land use and planning are based on Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and professional judgment. Effects on land use and planning are considered significant if the Proposed Project would result in one or more of the following conditions or situations:

- Physically divide an established community.
- Conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect in a manner that would prevent the avoidance or mitigation result sought to be achieved by the plan, policy, or regulation.

3.14.4 Impact Analysis Approach

The approach to the impact analysis for land use considers the baseline of existing uses of land and evaluates both the short-term Proposed Project construction-related activities as well as the potential long-term land-use conditions after the Proposed Project is completed. The analysis considers whether Proposed Project actions would create physical barriers that substantially change the connectivity between areas of a community or cause a significant environmental impact due to a conflict with a land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect. In addition to the analysis provided in Potential Impact 3.14-2, each resource topic analyzes applicable land use plans, policies or regulations that pertain to that topic. Consideration of habitat conservation plans and natural community conservation plans, which typically falls under the "Land Use and Planning" section of Appendix G of the CEQA Guidelines, is discussed in Section 3.5.4 *Impact Analysis Approach* of this EIR.

3.14.5 Potential Impacts and Mitigation

Potential Impact 3.14-1 Removal of the reservoirs, construction-related traffic, and/or land transfer would not change connectivity between areas of a community.
The Proposed Project includes the removal of the Lower Klamath Project reservoirs as well as restoration of the reservoir areas (Section 2 *Proposed Project*). The Proposed Project also includes the transfer of PacifiCorp lands immediately surrounding the Lower Klamath Project (i.e., Parcel B lands, see Figure 3.14-1) from PacifiCorp to the KRRC prior to dam removal, and then to California and Oregon, as applicable, or to a designated third-party transferee, following dam removal. The lands would thereafter be managed for public interest purposes (Section 2.7.10 *Land Disposition and Transfer*).

KRRC proposes to fence certain areas within the Area of Analysis for land use and planning. The Proposed Project would install cattle exclusion fencing around the reservoir restoration areas where they abut grazing land and where the existing topography does not already provide a barrier to cattle access (e.g., steep rocky terrain, residential areas, managed forests). The cattle exclusion fencing would be installed to protect revegetation efforts and to replace the function of the reservoirs as natural barriers to cattle movement*.* The exclusion fencing would be placed in accordance with applicable Federal, State, and county regulations and guidance *(*Appendix B: *Definite Plan – Section 6.1.1*). The proposed fencing would not physically divide an existing ranching community since it would be placed in locations where the reservoirs currently serve as a physical barrier to keep livestock on their designated lands and thus there would be no impact on connectivity relative to existing conditions.

PacifiCorp currently owns most of the land inundated by the reservoirs (Figure 3.14-2). Removing the reservoirs would remove lake water access for those in the community who use boats to travel between one reservoir recreational area to another (recreational impacts are discussed in Section 3.20 *Recreation*), or between residences. However, no roadways are proposed to be removed as part of the Proposed Project and although boating transport between reservoir shorelines would no longer be possible once the reservoirs are removed, there would be no change to road access as a result of reservoir removal. Since boating between reservoir shorelines as a means of travel is not the only available option for the community, reservoir removal would not create a physical barrier to travel for the community and there would not be a significant impact to connectivity due to the Proposed Project.

During construction activities, short-term, construction-related traffic could result in physical barriers to residents and local ranchers if road access were to be discontinued or substantially interrupted within the Area of Analysis. This would be a significant impact. Section 3.22 *Transportation and Traffic* analyzes the proposed Traffic Management Plan (Traffic Management Plan) included in Appendix B: *Definite Plan – Appendix O2*. Implementation of the proposed Traffic Management Plan would avoid the creation of a physical barrier to the community through construction strategies, such as scheduling, detour plans, signage and traffic control such that the potential impact would be less than significant.

The roads within the Area of Analysis, if not owned by Siskiyou County, are generally owned or managed by PacifiCorp (Figure 3.14-4). In the short term, between the time of license transfer and decommissioning of the dams, PacifiCorp would continue to maintain these roads (approximately 14.5 miles) as part of normal Lower Klamath Project operations and maintenance (KRRC and PacifiCorp 2017). After completion of the Proposed Project, these roads, which are primarily located on the south side of the California Lower Klamath Project reservoirs and were constructed for dam facility maintenance, may no longer be needed. While portions of these roads may currently be utilized by local residents, there are alternative access routes that connect to county roads, and so even if these roads are not maintained in the future, there would be no long-term physical barrier to road access under the Proposed Project and the impact would not be significant.

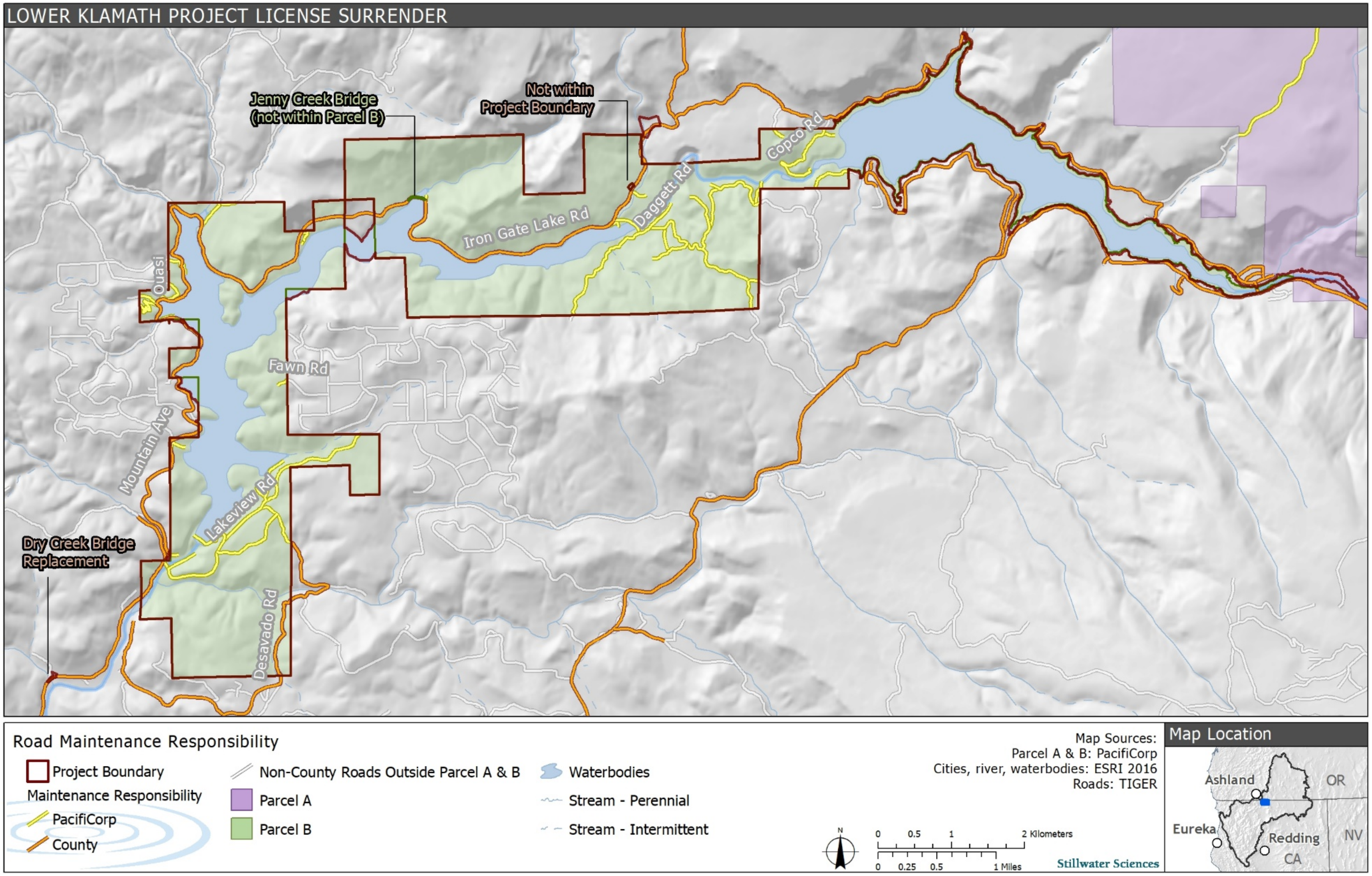

Figure 3.14-4. Road Maintenance Responsibility within the Land Use and Planning Area of Analysis.

Significance
No significant impact in the short term or long term

Potential Impact 3.14-2 The Proposed Project would not conflict with an applicable land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect in a manner that would prevent the avoidance or mitigation result sought to be achieved by the plan, policy, or regulation.
The Proposed Project includes the removal of the Lower Klamath Project dams and reservoirs and includes other items such as restoration of the reservoir footprints (see also Section 2.7.4 *Restoration Within the Reservoir Footprint*). Given the number of public agencies owning or regulating land use within the Area of Analysis for land use and planning, there are several relevant land use or land management plans to consider in association with the Proposed Project.

Siskiyou County
For the most part, the Area of Analysis is classified as Open Space – Natural Resources. All areas within the Area of Analysis for land use and planning are currently designated and zoned by the county's General Plan and Zoning maps (see Figure 3.14-3) and would continue to be classified as such after the Proposed Project is completed, resulting in no change from existing conditions. In addition, implementation of the Proposed Project itself would not change the county's General Plan designations or Zoning map.

General Plan of Siskiyou County
Non-federal lands within the land use and planning Area of Analysis are under the jurisdiction of the Siskiyou County General Plan (General Plan) (Siskiyou County 2017a). The General Plan applies to the unincorporated area of Siskiyou County, California, and includes separate elements that were adopted over the course of several years, primarily in the 1970–80s. Elements of the General Plan include land use, noise, conservation, energy, seismic safety, geothermal energy, and housing. The General Plan guides land use policy within the Area of Analysis, including Copco No. 1, Copco No. 2, and Iron Gate reservoirs and the surrounding recreational lands (FERC 2007).

Land use within the Area of Analysis would remain consistent with the Siskiyou County General Plan elements. For instance, removal of Lower Klamath Project facilities would be aligned with the objectives of the existing Siskiyou County Open Space element (which is to preserve 15 percent of the gross land area of a proposed development as open space, under either private or public ownership) and the Conservation element (which is to "conserve and protect the land resources" of the county, to "protect and conserve the lakes, streams and reservoirs of the county….for recreation areas but more important as wildlife habitat," and to "conserve and maintain habitat for wildlife species [including fish] and plant life."). The Proposed Project would replace certain lakes in Siskiyou County (i.e., the reservoirs) with a more natural river system (potentially including developed river recreational use areas) and habitat restoration, and other lakes in Siskiyou County would be preserved. Because the overall effect of the Proposed Project will be to preserve the water resources of Siskiyou County, the Proposed Project will not prevent the results that the Open Space and Conservation elements of the County's general plan are intended to achieve. Additionally, non-federal lands previously inundated by the Lower Klamath Project reservoirs, and surrounding Parcel B lands would be managed in the public interest and consistent with the Siskiyou County General Plan. Accordingly, the Proposed Project would be consistent, and not conflict, with county land use plans in a manner that would prevent the results sought to be achieved by those plans.

Siskiyou County Zoning Ordinance

Non-federal lands within the land use and planning Area of Analysis are under the jurisdiction of the Siskiyou County Zoning Ordinance (Siskiyou County 2017b). The Siskiyou County Zoning Ordinance guides land development in unincorporated portions of Siskiyou County by regulating allowable uses and structures in various zones. Uses within the Area of Analysis are generally residential, commercial, industrial, agricultural, timberland, and open space. Hydroelectric facilities, including changes to them, are subject to local review in part through the zoning code. The Area of Analysis for land use and planning is located on land zoned Open Space surrounded by: AG-1, prime agricultural; AG-2, non-prime agricultural; and R-R, rural residential agriculture. Most rural residential agriculture lands remain vacant. Since the uses on these lands would not change (i.e., agricultural lands would remain as agricultural, rural residential lands would remain as rural residential, and open space would remain as open space), the Proposed Project would not result in a conflict with the County's Zoning Ordinance that would prevent achievement of the objectives of the Zoning Ordinance.

The Wild and Scenic Rivers Act

The Wild and Scenic Rivers Act (P.L. 90-542) is discussed and analyzed in detail in Section 3.20 *Recreation*. Two portions of the Klamath River are currently designated under the Wild and Scenic Rivers Act. The first one is the 11-mile "scenic" segment from the California/Oregon state line to the J.C. Boyle powerhouse. The second "recreational" section for the Middle and Lower Klamath River begins 3,600 feet downstream of Iron Gate Dam and extends to the Pacific Ocean. Both of these segments are located outside of the Land Use Area of Analysis and, as described in Potential Impact 3.20-7, the Proposed Project would be beneficial to the long-term scenic quality, recreational quality, fisheries, and wildlife of the California Klamath River wild and scenic river segment, and it would be beneficial to the long-term resource values of the eligible and suitable wild and scenic river segment. Thus, the Proposed Project would not result in a conflict with the Wild and Scenic Rivers Act.

BLM Redding Resource Management Plan (RMP) (BLM 1993)

The Redding RMP is a 15-year strategy addressing where and how the BLM will administer public lands under its jurisdiction within the Redding Resource Area, which includes Butte and Tehama counties and the majority of Shasta, Siskiyou, and Trinity counties. As such, it governs management of BLM's Mallard Cove Recreation Area at Copco No. 1 Reservoir and several BLM parcels are crossed by transmission lines and Copco Road at Iron Gate Reservoir (FERC 2007). Recreational sites managed by BLM are discussed in Section 3.20 *Recreation*. The RMP objectives for the Klamath River include: maintaining water-oriented recreation opportunities along the river, improving the condition of the riparian zone to Class II on anadromous fish streams, and maintaining the scenic quality in the river condition upstream of Copco No. 1 Reservoir. Although the Proposed Project would result in the loss of one of BLM's reservoir accesses (i.e., the Mallard Cove Recreation Area), the Proposed Project would nevertheless be consistent with the objectives of the Redding RMP and would not prevent the result the RMP seeks to achieve. As discussed in more detail in Potential Impact 3.20-2, removal of this site would not result in a significant adverse impact on reservoir-based recreation because there are a number of similar opportunities in the vicinity of the Lower Klamath Project and, as described in Section 3.20 *Recreation*, the

Proposed Project will include a Recreation Plan which is expected to be finalized in June 2019. The Draft Recreation Plan includes potential recreation opportunities identified in the Detailed Plan (USBR 2012) as well as those identified through recent stakeholder outreach efforts. Thus, removal of the Mallard Cove Recreation site would not result in a substantial adverse land use impact.

USDA Forest Service Klamath National Forest Land and Resource Management Plan (USDA 2010)

The purpose of this plan is to coordinate and disclose programmatic management direction for the Klamath National Forest. The plan establishes the management direction and associated long-range goals and objectives for the forest; specifies the standards, timing, and vicinity of the practices necessary to achieve that direction; and establishes the monitoring and evaluation requirements needed to ensure that the direction is carried out. There are no lands of the Klamath National Forest within the Project Boundary, although there are some parcels near the east end of Copco No. 1 Reservoir. The plan designates those lands as late-successional reserve, and are managed to enhance habitat for late-successional and old growth-related species (FERC 2007). Additional analysis of Forest Lands is found in Section 3.15 *Agriculture and Forestry Resources*. That analysis concludes that the Proposed Project will not result in a conflict with the Klamath National Forest Land and Resource Management Plan in a manner that will cause a substantial adverse impact to the physical environment. See Section 3.15 *Agriculture and Forestry Resources* for more information on forest resources.

Significance

No significant impact

3.14.6 References

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3.15 Agriculture and Forestry Resources

This section discusses potential impacts on agricultural and forestry resources under the Proposed Project. This section describes existing agricultural land uses in Siskiyou County, in which the Proposed Project is located, identifies the acreage of agricultural lands in the county, including Important Farmland and Grazing Land, and describes the factors contributing to potential changes in irrigated agricultural land as a result of the Proposed Project. The forestry resources analysis focuses on the direct changes that would occur as a result of dam removal under the Proposed Project. In support of the forestry impact analysis, this section describes existing tree species, forested acreages, riparian vegetation, and large woody debris in the Area of Analysis (see below).

Relatively few comments were received during the NOP public scoping process relating to agriculture. Some of the comment topics are not analyzed in the Lower Klamath Project EIR because they are do not concern environmental impacts of the Proposed Project. One comment expressed concern that landowners in the Scott and Shasta valleys will be required to stop farming in light of water supply impacts from the Proposed Project; while this comment was not accompanied by supporting evidence, this section does address the concern in light of the public's interest. Potential impacts of the Proposed Project on water supply, which by definition includes water supply for agriculture, are discussed in detail Section 3.8 *Water Supply/Water Rights*). Potential impacts related to flood control are discussed in Section 3.6 *Flood Hydrology*.

No public comments were received during the NOP public scoping process regarding forestry resources. See Appendix A for additional information regarding scoping comments.

3.15.1 Area of Analysis

For agricultural and forestry resources the Area of Analysis includes all lands within the Project Boundary plus a half-mile buffer around Copco No. 1 (Figure 3.15-1). This analysis area was chosen to correspond with the area where changes in hydrology and water supply are anticipated due to the Proposed Project and could indirectly affect irrigated agriculture. Additional information pertaining to the potential hydrologic and water supply impacts of the Proposed Project are presented in Sections 3.6 *Water Supply/Water Rights* and 3.8 *Flood Hydrology*.

3.15.2 Environmental Setting

3.15.2.1 Important Farmland

The California Department of Conservation (DOC) developed land use classifications for farmland in Siskiyou County. These classifications are based on the land's suitability for agricultural production by considering physical and chemical characteristics of the soil (soil temperature range, depth of the groundwater table, flooding potential, rock fragment content, and rooting depth), location, growing season, and moisture available to sustain high-yield crops. Analyses of these characteristics were used to develop "Important Farmland" classifications that include Prime Farmland, Farmland of Statewide Importance, Unique Farmland, and Farmland of Local Importance. Along with Grazing Land, these Important Farmland classifications were collectively defined by the DOC as "Agricultural Land."

DOC (2016a) estimated that Siskiyou County had 1,146,245 acres of agricultural land in 2012, of which 756,486 acres were identified as Important Farmland and 389,759 acres as Grazing Land (DOC 2016a). In 2014, Siskiyou County had 1,146,010 acres of agricultural land. Of this total, 754,297 acres were identified as Important Farmland and 391,713 acres were identified as Grazing Land (DOC 2016a). Table 3.15-1 summarizes the most recent DOC farmland conversion data, identifies the 2012 and 2014 acreages of agricultural land in Siskiyou County, and shows the net change in acreage over the two-year period.

Table 3.15-1. Summary of Agricultural Land Conversion in Siskiyou County, 2012–2014.

Important Farmland Category	Acres		Net Change (2012–2014)	
	2012	2014	Acres	Percent
Prime Farmland	74,973	70,724	-4,069	-5.6
Farmland of Statewide Importance	27,305	25,963	-1,342	-4.9
Unique Farmland	34,838	35,365	527	1.5
Farmland of Local Importance	619,550	622,245	2,695	0.4
Important Farmland Subtotal	**756,486**	**754,297**	**-2,189**	**-0.3**
Grazing Land	389,759	391,713	1,954	0.5
Agricultural Land Total	**1,146,245**	**1,146,010**	**-235**	**-0.02**

Source: DOC 2016a

DOC's 2014 Field Report for Siskiyou County identifies the factors contributing to changes in agricultural land uses from 2012–2014. According to the 2014 Field Report, some Important Farmland (i.e., Prime Farmland, Farmland of Statewide Importance, or Unique Farmland) was converted to Farmland of Local Importance and Grazing Land by leaving formerly irrigated land idle for three or more reporting update cycles, going out of production, or conversion of irrigated uses to cultivation of non-irrigated grain crops (DOC 2016b). A total of 24 acres were converted from farmland to urban and built-up land between 2012 and 2014 (DOC 2016a).Conversely, irrigated cropland was added near the town of Dorris. Additions of new cropland were primarily alfalfa or other irrigated hay crops, often in the form of center-pivot fields (DOC 2016b).

Most of the land in the Area of Analysis is classified by the DOC as Grazing Land, with a small area of Unique Farmland located approximately two miles south of Copco No. 1 Reservoir (Figure 3.15-1).

Parcels zoned by Siskiyou County for Agriculture-Grazing are located within the Area of Analysis to the north and south of Copco No. 1 Reservoir (Figure 3.14-1). There are a number of parcels located immediately upstream of Copco No. 1 Reservoir that are used primarily for grazing and hay production. The DOC (2016c) identified these lands as Prime Farmland or Farmland of Statewide Importance (Figure 3.15-1). The pastures/fields on these properties are flood-irrigated via direct diversions from the free-flowing Klamath River upstream of Copco No. 1 Reservoir. There are a few agriculture parcels with grazing land located between 1.2 and 3 miles north of Copco No. 1 Reservoir (Figure 3.15-1). Another agricultural operation is located on land designated as Farmland of Local Importance and is approximately 0.5-miles southwest of Keaton Cove along the Ager-Beswick Road in the Deer Creek drainage. The pastures on all these properties are flood-irrigated from direct diversions on tributary streams that flow into the reservoir. None of the properties mentioned above rely on Copco No. 1 Reservoir for irrigation water.

The land surrounding Iron Gate Reservoir is entirely BLM or Parcel B property and does not contain any parcels zoned for agriculture under the Siskiyou County General Plan (Figure 3.14-1). DOC (2016) describes most of the terrain around Iron Gate Reservoir as grazing lands. However, there is some open, relatively flat land south of the reservoir in the Long Gulch watershed that is broken into individual parcels that seem based on a review of Google Earth (2016a) aerial imagery, to be used primarily for what appears to be cannabis production. The DOC (2016c) identified these Long Gulch lands as Farmland of Local Importance or suitable for grazing (Figure 3.15-2). Based on a review of Google Earth (2013 and 2016a) aerial photographs, the water source for these parcels appear to be wells. The elevation of these parcels ranges from 110 to 140 feet above the reservoir water surface elevation with the closest parcel being 0.34 miles south of Iron Gate Reservoir.

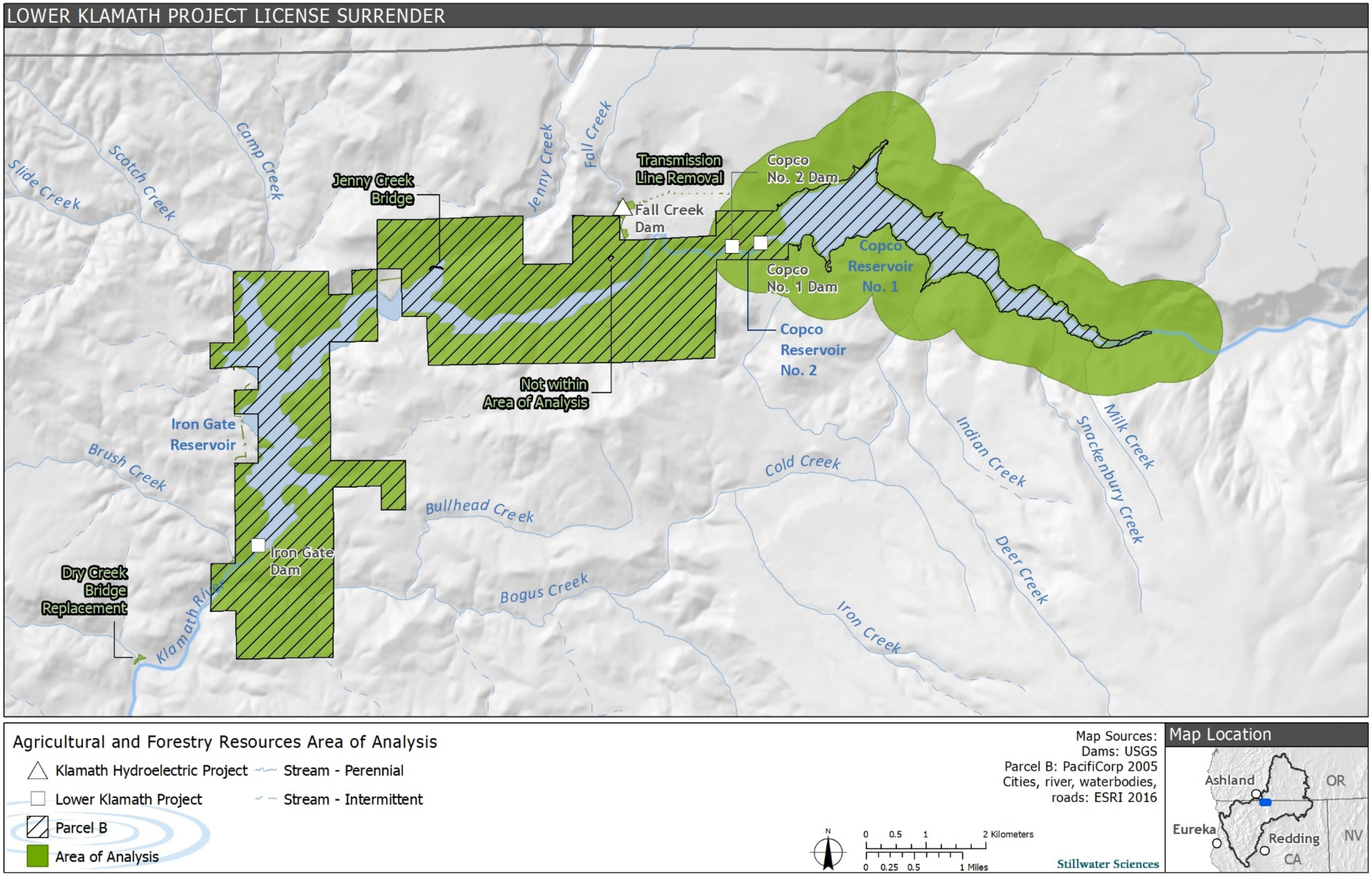

Figure 3.15-1. Agricultural and Forestry Resources Area of Analysis.

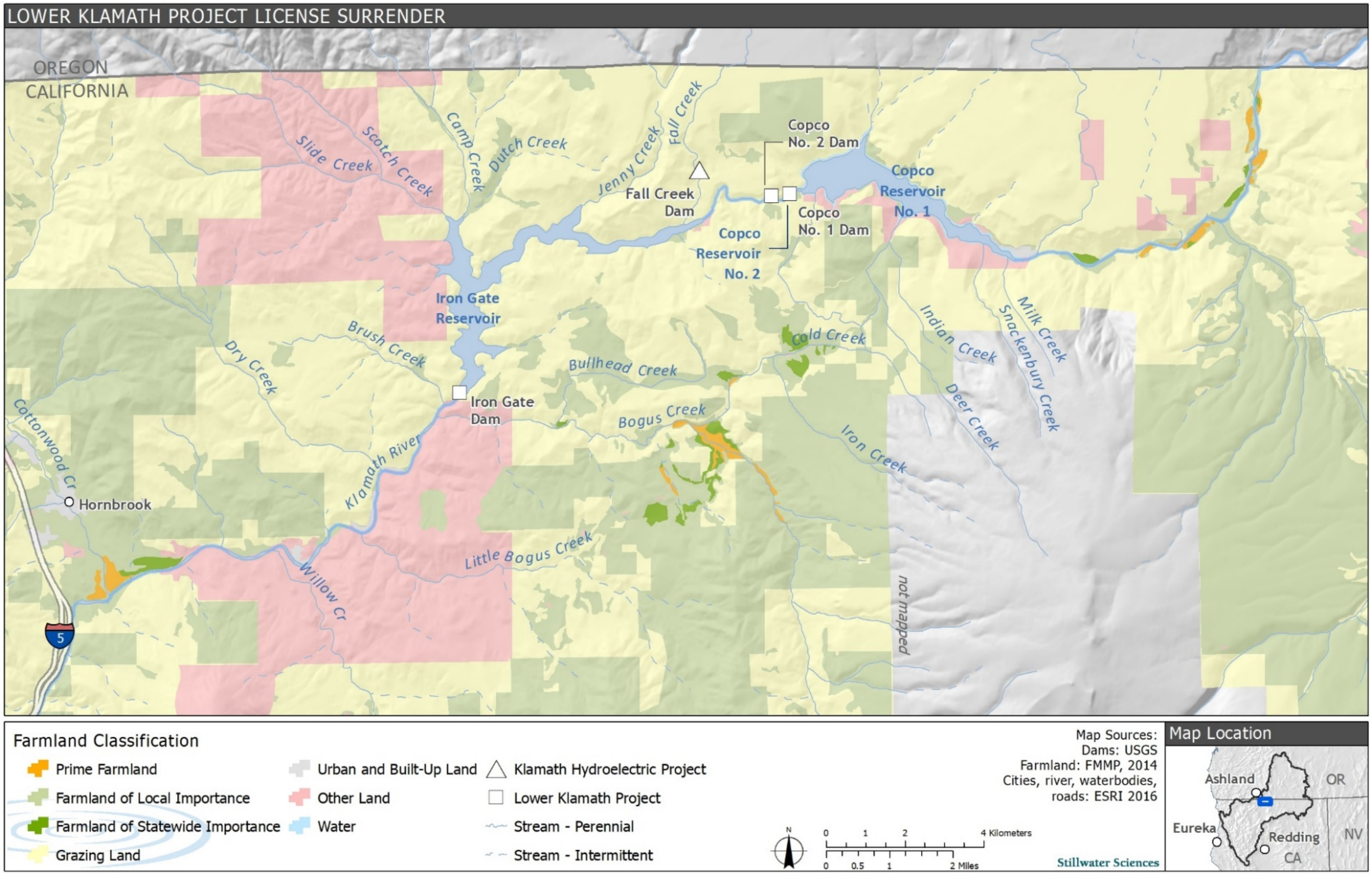

Figure 3.15-2. Farmland classification along the Klamath River from Interstate 5 to the Oregon-California state line (Adapted from DOC 2016c).

3.15.2.2 Existing County Zoning

Lands currently inundated by the reservoirs in Siskiyou County have land use zoning classifications that correspond with the adjacent lands (generally Rural Vacant, Agriculture-Grazing, or Open Space-Natural Resources). There are no lands zoned for forestry resources within the Area of Analysis from the eastern end of Copco No. 1 Reservoir downstream to Iron Gate Dam (Figure 3.14-1). If dam removal occurs, the submerged lands would not require new land use designations or zoning because they do not change with an ownership transition until there is some action that triggers rezoning and a land use amendment (Plucker 2011).

3.15.2.3 Williamson Act

Under the California Land Conservation Act of 1965, also known as the Williamson Act, local governments can enter into contracts with private property owners to protect land (within agricultural preserves) for agricultural and open space purposes. Siskiyou County had 421,125 acres under Williamson Act contracts in 2013, the most recent year for which data are available (DOC 2015). The nonrenewal of a contract is the most common mechanism for termination of Williamson Act contract lands. In Siskiyou County in 2013, approximately 2,428 acres were in some stage of the nonrenewal process, approximately seven acres of contract land terminated through nonrenewal expirations, and no property owners initiated new nonrenewal processes (DOC 2015).

No Williamson Act parcels are within the agriculture and forestry Area of Analysis. Twelve parcels located within five miles of project facilities are under Williamson Act contracts and the nearest of which are located approximately two miles south of Copco No. 1 Reservoir.

3.15.2.4 Forestry Resources

The Lower Klamath Project is located in a transition zone between the Great Basin and California Floristic provinces. In Oregon, the Lower Klamath Project (i.e., J.C. Boyle facilities) generally is located within the interior valley, ponderosa pine, and mixed conifer vegetation zones. In California, similar upland tree habitats are present, but the representation of ponderosa pine, mixed conifer, and lodgepole pine is lacking or much reduced. Further, there are no lands that are zoned Forest Resources under the Siskiyou County General Plan within the agriculture and forestry Area of Analysis (Figure 3.14-1). However, some of the lands (primarily near the upstream end of Copco No. 1 Reservoir) in the Lower Klamath Project may be managed for forest resources as a compatible use with existing Open Space zoning.

PacifiCorp (2004) identified and mapped a variety of land cover types from the Link River Dam to the Shasta River. In addition, vegetation datasets are available through CALVEG (Classification and Assessment with Landsat of Visible Ecological Groupings) datasets available through the California Land Cover Mapping & Monitoring Program (USDA Forest Service 2017a) and data from USFWS (2017). These datasets were utilized to create the vegetation maps presented in Appendix G: *Vegetation Communities and Habitat Types* and provide summary acreages described in Table 3.5-1. The upland tree acreage between the Oregon-California state line and Iron Gate Dam and extending 0.25 miles on either side of the Klamath River is presented below in Table 3.15-2. See Section 3.5.2.1 *Vegetation Communities* for a description of the vegetation types within 0.25 miles of the Klamath River between the Oregon-California state line and the Klamath River Estuary.

Table 3.15-2. Upland tree habitats and mapped between the Oregon-California state line and Iron Gate Dam.

Upland Tree Habitats	Acres	Description, Dominant Species, and Location
Montane hardwood oak	1,813	Moderately open tree canopy, moderately dense shrub layer, moderately dense herbaceous layer. Yellow starthistle and medusahead occur in about 25 percent of stands in the project vicinity. Most abundant around Copco No. 1 Reservoir.
Montane hardwood oak-conifer	2,656	Dense tree cover, sparse shrub layer, moderately open herbaceous layer. Most abundant along the J.C. Boyle Peaking and Bypass reaches, at Copco No. 1 Reservoir, at Fall Creek, and along the Copco No. 2 bypassed reach.
Ponderosa pine	68	Moderate canopy cover, relatively sparse shrub cover, moderately open herbaceous layer.
Juniper	457	Open canopy, shrub layer varies from sparse to dense, herbaceous layer ranges from sparse to dense.
Mixed conifer	9	Dense tree cover often is two-layered, open shrub layer, moderately sparse herbaceous layer.
Total of all upland tree habitats	5,003	

Late-successional Conifer Forest

According to the Northwest Forest Plan (USDA Forest Service and BLM 1994), late-successional forests are those in which the biggest, oldest, and most dominant trees create a mature canopy, with shade-tolerant trees occupying and flourishing on the forest floor. Typically, late-successional forests include trees at least 80 years old. Late-successional forests provide important habitat for a large number of wildlife species.

PacifiCorp (2004) determined that only 13 acres of forest near the J.C. Boyle peaking reach include late-successional conifer forest with large-diameter trees[165]. However, 8,435 acres of younger forests, having trees with small to moderately large diameters (11 to 24 inches) also occur (PacifiCorp 2004 as referenced in FERC 2007) between J.C. Boyle and Shasta River. No late-successional conifer forest exists within the Lower Klamath Project.

3.15.3 Significance Criteria

For the purposes of this EIR, impacts on Agriculture and Forestry Resources would be significant if they resulted in the following:

- Substantial conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the

[165] Large-diameter trees are greater than 24 inches in diameter, as measured 4.5 feet above the forest floor.

Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use.

- Conflict with existing zoning for agricultural use or a Williamson Act contract where the conflict would result in a substantial adverse environmental impact.
- Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code Section 12220(g)), timberland (as defined by Public Resources Code Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104(g)).
- Substantial loss of forest land or conversion of forest land acreage to non-forest use.
- Other changes in the existing environment that could result in significant conversion of Farmland acreage to non-agricultural use, or significant conversion of forest land acreage to non-forest use.

3.15.4 Impact Analysis Approach

Existing land uses were identified from a variety of sources including Federal and State agencies and the respective counties. The effects analysis identifies direct and indirect effects on agricultural and forest resources under the No Project Alternative, the Proposed Project, and the other alternatives. The types of potential effects that were analyzed included temporary effects associated with dam removal, demolition, and staging and permanent effects such as changes in land use and required changes to local land use plans and zoning ordinances. The State Water Board also considered possible conflicts or inconsistencies between the proposed alternatives and Federal, State, regional, local, or tribal land use plans, policies, or controls relevant in the area of analysis. Temporary and permanent direct and indirect conversions of agricultural and forest lands were also analyzed.

This section includes an evaluation of potential conflicts between the existing and proposed agriculture and forestry land uses associated with the Proposed Project. Physical changes resulting from the Proposed Project and the various alternatives (Section 4 *Alternatives*) are addressed throughout this EIR. Where significant adverse environmental impacts would occur, this EIR offers mitigation measures for reducing the physical impacts on the environment that would be caused by the Proposed Project.

3.15.5 Potential Impacts and Mitigation

Agriculture and forest use resources within the area of analysis are regulated by several Federal, State, and local plans, laws, and policies, which are listed below and considered in this assessment.

- Farmland Protection Policy Act of 1981
- USDA Forest Service Klamath National Forest Land and Resource Management Plan
- California Land Conservation Act of 1965 (Williamson Act)
- California Forest Practice Rules
- Siskiyou County Zoning Ordinance

The Farmland Protection Policy Act (FPPA) of 1981 is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It assures that to the extent possible federal programs are administered to be compatible with state, local units of government, and private programs and policies to protect farmland. Federal agencies are required to develop and review their policies and procedures to implement the FPPA every two years. The FPPA does not authorize the Federal Government to regulate the use of private or nonfederal land or, in any way, affect the property rights of owners. For the purpose of FPPA, farmland includes prime farmland, unique farmland, and land of statewide or local importance. Farmland subject to FPPA requirements does not have to be currently used for cropland. It can be forest land, pastureland, cropland, or other land, but not water or urban built-up land. Projects are subject to FPPA requirements if they may irreversibly convert farmland (directly or indirectly) to nonagricultural use and are completed by a Federal agency or with assistance from a Federal agency.

The Klamath National Forest Land and Resource Management Plan is used to coordinate and disclose programmatic management direction for the Klamath National Forest. The plan establishes the management direction and associated long-range goals and objectives for the forest; specifies the standards, timing, and vicinity of the practices necessary to achieve that direction; and establishes the monitoring and evaluation requirements needed to ensure that the direction is carried out. There are no lands of the Klamath National Forest within the Project Boundary, although there are some parcels near the east end of Copco No. 1 Reservoir. The plan designates those lands as late-successional reserve, and are managed to enhance habitat for late-successional and old growth-related species (FERC 2007).

The Williamson Act enables local governments to enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open space use. In return, landowners receive property tax assessments which are much lower than normal because they are based upon farming and open space uses as opposed to full market value.

The California Forest Practice Rules were developed to implement the provisions of the Z'berg-Nejedly Forest Practice Act of 1973 in a manner consistent with other laws, including but not limited to, CEQA. The intent of the rules is that no timber harvesting plan shall be approved which fails to adopt feasible mitigation measures or alternatives from the range of measures set out or provided for in these rules, which would substantially lessen or avoid significant adverse impacts which the activity may have on the environment. The Lower Klamath Project does not propose to harvest timber as part of the Proposed Project.

The Siskiyou County zoning ordinance guides land development in unincorporated portions of Siskiyou County by regulating allowable uses in various zones. Non-federal lands within the land use and planning Area of Analysis are under the jurisdiction of this ordinance. Zones are grouped by six main uses—residential, commercial, industrial, agricultural, timberland, and open space (see Section 3.14 *Land Use and Planning* for more information). Hydroelectric facilities are subject to local review in part through the zoning code. The Area of Analysis for land use and planning is located on land zoned Open Space surrounded by: AG-1, prime agricultural; AG-2, non-prime agricultural; and R-R, rural residential agriculture. Most rural residential agriculture lands remain vacant.

Potential Impact 3.15-1 Conversion of Farmland to non-agricultural use or conflict with Williamson Act land or agricultural zoning.

The Proposed Project would use existing road systems to facilitate dam decommissioning and removal. However, upgrades to existing roads would be necessary to allow for the heavy traffic expected during deconstruction. The disposal site for Iron Gate Dam spoils is located on flat land approximately 3,000 feet northeast of the dam. The permanent disposal site for deconstruction spoils from Copco No. 1 and No. 2 would occur at the current location of the maintenance buildings and residence. Disposal sites at J.C. Boyle Dam will include the original borrow sites, spillway, scour hole below the emergency spillway, and abutment locations. As these roads and disposal sites are existing and/or on lands not designated for agriculture, their use for disposal would not directly convert Farmland to non-agricultural use. The analysis of the capacity and use of existing roads is presented in Section 3.22 *Transportation and Traffic*. The Proposed Project would not result in the conversion of farmland within the Area of Analysis for agriculture and forestry resources to non-agricultural uses, and it would not conflict with existing zoning or Williamson Act contracts. There can be no conflict with Williamson Act land because there are no contract parcels within the agriculture and forestry Area of Analysis. Agricultural zoning would not change since existing classifications would remain the same following drawdown. Reservoir drawdown may increase agricultural opportunities on currently inundated lands; however, due to uncertainties in the ultimate land use of the inundated reservoir lands, this is speculative (see also Section 2.7.11 *Land Disposition and Transfer*). The Parcel B lands could ultimately be managed for wide potential range of public interest uses, including but not limited to open space, active wetland and riverine restoration, river-based recreation, grazing, and potentially other uses.

Significance

No significant impact

Potential Impact 3.15-2 Conversion of forest lands to non-forest use or conflict with forest zoning.

Implementation of the Proposed Project would not affect the forest lands or forest uses surrounding Copco No. 1, Copco No. 2, or Iron Gate reservoirs or in the larger agriculture and forestry Area of Analysis. There are no lands zoned for forest resources within the Area of Analysis, from the eastern end of Copco No. 1 Reservoir downstream to Iron Gate Dam (Figure 3.14-1). The Proposed Project would use existing road systems to facilitate dam decommissioning and removal. However, upgrades to existing roads would be necessary to allow for the heavy traffic expected during deconstruction. The disposal site for Iron Gate Dam spoils is located on flat land approximately 3,000 feet northeast of the dam. The permanent disposal site for deconstruction spoils from Copco No. 1 and No. 2 would occur at the current location of the maintenance buildings and residence. Disposal sites at J.C. Boyle Dam will include the original borrow sites, spillway, scour hole below the emergency spillway, and abutment locations. The vegetation would be removed in preparation for debris disposal. Topsoil would be used to cap the site and be seeded once disposal is completed. Trees would be planted on the finished disposal sites. As these roads and disposal sites are existing and/or on lands not designated for forestry, their use for disposal would not directly convert forest lands to non-forest use. Thus, there would be no changes in land use under the Proposed Project that would conflict with current forest use or zoning. There is the potential for an increase in forest land due to revegetation of previously inundated lands with woody species, however the full extent to which lands would reseed with forest species is unknown.

Significance

No significant impact

Potential Impact 3.15-3 Indirect conversion of Farmland to non-agricultural use or forest land to non-forest use.

The Proposed Project would use existing road systems to facilitate dam decommissioning and removal. However, upgrades to existing roads would be necessary to allow for the heavy traffic expected during deconstruction. Disposal sites are located as described above. The use of these roads or disposal areas would not indirectly convert farmland to non-agricultural use or forest land to non-forest use.

Significance

No significant impact

Potential Impact 3.15-4 Other changes in the existing environment that could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use.

The Proposed Project would not involve other changes in the existing environment that could result in the conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use. For example, the irrigated farmlands classified as Prime or of Statewide Importance are located primarily at the farthest eastern extent of Copco No. 1 Reservoir and farther upstream along the Klamath River (Figure 3.15-2). These farmlands are flood-irrigated from direct diversions that are either located on the free-flowing reach of the Klamath River upstream of the Project or along tributaries. The headworks of these diversions would still be operational following the removal of the dams since they are situated on the natural channels of the river and tributaries and do not divert from the Lower Klamath Project reservoirs. Impacts on agricultural crops (primarily hay production) are not expected since the irrigation season occurs after the scheduled drawdown period (November to March; see also Table 2.7-1) and these fields are not reliant on the reservoirs for their water supply. There is a possibility that agricultural diversion headworks downstream of each dam would experience siltation or otherwise be affected during reservoir drawdown. However, the Proposed Project includes measures to address these temporary supply issues (see Potential Impact 3.8-3).

Farmlands of Local Importance are located primarily in the Deer Creek drainage that flows into Copco No. 1 Reservoir along the south shoreline and in the Camp and Dutch creek watersheds on the north side of Iron Gate Reservoir (Figure 3.15-1). Based upon analysis of Google Earth (2013 and 2016b) aerial imagery and well data in Section 3.7 *Groundwater*, these lands are irrigated by diversions from their respective tributaries or use wells for stock watering and do not rely on water within the reservoirs for irrigation. See Section 3.7 *Groundwater* for an analysis of groundwater issues.

In the Lower Klamath Basin, some agricultural diversion of water occurs for farming and ranching from tributaries such as the Shasta, Scott, Salmon, and Trinity rivers. However, the Lower Klamath Project is located on the mainstem Klamath River. Therefore, these diversions of water from tributaries would not be affected by removal of the Lower Klamath Project dams. In addition, removal of the Lower Klamath Project dams would not place flow obligations on small agricultural diverters in tributaries to the Klamath River or the mainstem itself. (see Potential Impact 3.8-1 for more information.) Ongoing efforts to establish minimum flow requirements in the Mid and Lower Klamath basins and prior flow standards recommended by the North Coast Regional Water Quality Control Board focus only on the flow needs of Klamath River tributaries and do not consider any flow contributions to the mainstem river.

Disposal of Iron Gate Dam demolition debris would be placed on a 36-acre plot of Parcel B land approximately one mile south of the dam. This area is currently zoned as Open Space – Natural Resources under the Siskiyou County General Plan, but is open, non-irrigated grassland that is used for grazing. The site would be cleared of vegetation and topsoil in preparation for debris disposal, which would temporarily halt any grazing activity. Once disposal is completed, the site would be regraded, capped with topsoil, and seeded. This would restore the area and allow for continued grazing. This temporary disturbance would be a less than significant impact in light of the availability of other lands for grazing and the small area involved.

Areas around the Lower Klamath Project reservoirs currently support open range grazing by cattle, which are able to move freely around the reservoir areas, with the exception of areas that present topographic barriers. To protect revegetation efforts and to replace the function of the reservoirs as natural barriers, the KRRC is proposing to use cattle exclusion fencing around the reservoir areas after drawdown. The proposed fencing would be a wildlife friendly design that excludes open-range cattle while allowing the natural movement of deer, turtles, and other wildlife. The fence may be required to fully isolate the reservoir restoration areas. No grazing land would be lost as a result of the fence installation since the fencing would only surround the currently inundated lands. Therefore, the proposed fencing would result in no significant impact.

Scoping comments expressed the concern that reservoir removal could affect local groundwater wells. However, based on available information, Farmland within the Area of Analysis does not rely upon groundwater wells for cultivated area irrigation, instead using flood irrigation by diverting surface water from tributaries to the Klamath River. Within the Area of Analysis, there are two wells located on Farmland of Local Importance in the Deer Creek subwatershed (tributary to Copco No. 1 Reservoir) and another in the Camp Creek subwatershed (tributary to Iron Gate Reservoir) that may be used for stock watering. The Deer Creek subwatershed wells are located approximately 2,000 ft south of Copco No. 1 Reservoir and adjacent to Deer Creek. As such, they are likely highly influenced and recharged by Deer Creek. The bottom of the Camp Creek well extends below the Iron Gate Reservoir bed elevation. Therefore, the Proposed Project's effect on agriculture-related wells within the Area of Analysis would not be likely to result in the conversion of Farmland to non-agricultural uses and there would be a less than significant impact. In any event, implementation of the Groundwater Well Management Plan (as described in Section 2.6.8.6 *Groundwater Wells Management* and in Appendix B: *Detailed Plan*), including well deepening, would return the production rate of any affected groundwater supply well to conditions experienced prior to dam decommissioning. Therefore, the potential for conversion of Farmland to non-agricultural uses resulting from lowering groundwater levels as a result of the Proposed Project would be less than significant.

The land within the agriculture and forestry Area of Analysis is not zoned forest land, does not contain commercial forest land, and is not used for forestry purposes.

However, the Lower Klamath Project would allow previously inundated lands to revegetate and potentially increase the amount of forest cover within the Area of Analysis, which would be beneficial for forest land. Therefore, the Lower Klamath Project would not result in conversion of forest land to non-forest use in the short term or long term.

Significance

No significant impact for conversion of farmland to non-agriculture uses

No significant impact for conversion of forest land to non-forest use

3.15.6 References

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3.16 Population and Housing

This section discusses existing population and housing data and potential impacts associated with the Proposed Project. The following subsections describe the environmental setting with respect to demographics and housing data in the Area of Analysis defined below. This analysis uses data from the U.S. Census, county and city plans, and other sources for projected housing availability.

The State Water Board did not receive any comments related to population and housing issues during the NOP public scoping process (see Appendix A).

3.16.1 Area of Analysis

The Area of Analysis for population and housing extends beyond the Project Boundary to encompass the following urban and rural communities in California: the community of Hornbrook, the City of Yreka, and the residential rural areas near Copco No.1, Copco No. 2, and Iron Gate reservoirs. The Area of Analysis includes communities with the potential to house workers migrating into the area for Proposed Project construction activities (see also Section 3.16.4 *Significance Criteria*). The Area of Analysis also includes the area where two residences downstream of Iron Gate Dam are noted to be affected by change in flood elevations (FEMA 100-year floodplain) as well as 34 habitable structures that are already affected by these flood elevations. Effects of flood elevations upon these residences are analyzed in more detail in Section 2.7.8.4 *Downstream Flood Control* and in Section 3.6 *Flood Hydrology*, where it was determined that “loss of structures that are not feasible to move or elevate would be a significant impact.”

3.16.2 Environmental Setting

Regulations at the federal, state, and local levels regarding housing are generally concerned with the proper construction, provision of, and the siting of housing for a variety of incomes. Since no new residential structures are proposed as part of the proposed project, this is not analyzed further.

The Proposed Project does not call for the construction of new homes. There are approximately 12 residences proposed for demolition currently owned by PacifiCorp for use by workers maintaining the dams or other PacifiCorp properties. There will be no need to replace these residences.

As noted above, 36 residences downstream of Iron Gate Dam are affected by change in the FEMA 100-year floodplain elevations. The impacts to these residences are analyzed in Section 3.6 *Flood Hydrology*. Since these residences represent only 0.15 percent of the total County housing stock, they are not considered a substantial loss and are not further addressed in the Population and Housing section.

Siskiyou County census data is presented, along with data for Yreka and Hornbrook. Yreka and Hornbrook could both temporarily house workers needed for the Proposed Project. According to the U.S. 2010 Census, Yreka had a population of approximately 7,800 and Hornbrook had a population of approximately 250. However, approximately

82 structures were destroyed in 2018 by the Klamathon Fire[166] in the general Hornbrook area, thereby potentially affecting available housing noted in the 2010 Census.

3.16.2.1 Demographic Data

According to Siskiyou County Housing Element (Siskiyou County 2014), the population in Siskiyou County was expected to grow from a population of 44,893 persons in 2010 to 46,369 persons in 2020, representing a three percent increase in population. U.S. Census Bureau 2017 noted that the population of Siskiyou County has been in slow decline since 2010 with July 1, 2017 population estimate at 43,853.

According to the California Employment Development Department (California Employment Development Department 2018), there were a total of 17,210 workers employed in August 2018, and 1,000 unemployed (5.5 percent unemployment). This is up from the 16,770 jobs in Siskiyou County August 2013, which reflected employment in the midst of an economic downturn, with 11 percent of the county's workforce unemployed. Conversely, there were 18,140 jobs in Siskiyou County as of September 2000, when unemployment was at a 20-year low (5.8 percent unemployment). Construction trades amounted to 7.6 percent of the workforce with 1,282 jobs. (Siskiyou County 2014).

3.16.2.2 Housing Data

Table 3.16-1 shows housing and occupancy estimates for Siskiyou County based on 2010 U.S. Census data. Siskiyou County's overall vacancy rate was 18.4 percent representing 4,405 units. Hornbrook had a high vacancy rate, at 30.8 percent, out of 156 total units in 2010. Yreka and its surrounding area had a lower housing availability vacancy rate of 7.6 percent, which is still more than twice California's 2016 vacancy rate of 3.3 percent). There were 281 vacant units available for rent in the City of Yreka (U.S. Census Bureau 2010b).

[166] More details about the Klamathon Fire can be found online at: http://www.fire.ca.gov/current_incidents/incidentdetails/Index/2108 (Accessed December 19, 2018).

Table 3.16-1. Siskiyou County Housing Units (2010 Census information).

	Hornbrook		City of Yreka		Siskiyou County	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Occupied Housing Units	108	69.2	3,394	92.4	19,505	81.6
Owner-Occupied	72	66.7	1,751	51.6	12,629	64.7
Renter-Occupied	36	33.3	1,643	48.4	6,876	35.3
Vacant Housing	48	30.8	281	7.6	4,405	18.4
Total Housing Units	**156**		**3,675**		**23,910**	

Source: U.S. Census Bureau 2010b

Updated information for 2016 (U.S. Census Bureau 2016) indicates that there were 317 vacant units in Yreka and 4,989 vacant units in the County. As noted earlier, the Klamathon Fire destroyed 82 structures in the Hornbrook area and it is unknown how this translates to loss of available rental units.

The Yreka Housing Element reports 2013 rental costs ranging from $475 to $1,100 per month (City of Yreka 2014). According to the 2012-2016 American Community Survey five-year estimate, the median monthly rent in the City of Yreka was $758 and for Siskiyou County $828 (U.S. Census Bureau 2016).

3.16.3 Significance Criteria

Criteria for determining significance on population and housing are based Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.). Effects on population and housing are considered significant if the Proposed Project would result in one or more of the following conditions or situations:

1. Induce substantial unplanned population growth in an area, either directly (e.g., by proposing new homes and businesses) or indirectly (e.g., through extension of roads or other infrastructure).
2. Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere.

3.16.4 Impact Analysis Approach

The Proposed Project will not directly cause the elimination of existing housing (except for removing existing PacifiCorp housing, which is no longer needed). The Proposed Project will also not create a long-term increase in housing needs or induce long-term population growth. The analysis of potential effects of the Proposed Project is therefore focused on the temporary worker population required for construction activities and their potential need for housing within the Area of Analysis. The peak need for worker housing would occur over an approximate two-year construction period with lesser need for housing during preparation and follow-up restoration/monitoring activities. Hatchery personnel would remain the same as currently occurring.

The impact analysis is therefore determined by comparing projected housing needs with projected housing availability. Communities were analyzed for their potential to temporarily house workers using California Department of Finance housing and population data, where available, in addition to city level and Census Block Group level 2010 U.S. Census data (U.S. Census Bureau, 2010a–c) and 2012-2016 American

Community Survey data (U.S. Census Bureau 2016), and county and city plans, where available.

3.16.5 Potential Impacts and Mitigation

Potential Impact 3.16-1 Inducing substantial unplanned population growth in an area, either directly or indirectly.
The Proposed Project would not directly induce substantial population growth, as it does not require the construction of new homes or the demolition of existing homes (except for a small number of residences owned by PacifiCorp and used by workers maintaining the dams (see also Potential Impact 3.16-2). The potential effects of the Proposed Project would be limited to the influx of the temporary worker population required for construction activities (see Table 2.7-13). Proposed construction activities would require an average of 105 workers and a peak of 175 workers during the anticipated four-month peak period when work on three dams would occur at the same time. During the majority of the two-year construction activity period there would be fewer workers (35-105) required. Table 3.16-1 indicates that the City of Yreka has 317 vacant units and the County, as a whole, has 4,989 vacant units, some of which may be close enough to the Proposed Project to provide an ample supply for the short-term influx of workers. It is also likely that many from the local construction workforce (7.6 percent of the workforce with 1,282 jobs. (Siskiyou County 2014) will already live in the county and will not need short-term housing. As such, the Proposed Project would not result in a substantial influx of population and there would be a less than significant impact on population growth in the Area of Analysis.

<u>Significance</u>
No significant impact

Potential Impact 3.16-2 Displacement of substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere.
The residential communities of Ager and Beswick surround Copco No.1 Reservoir (34 miles from Yreka) and Iron Gate Reservoir (25 miles from Yreka). The Proposed Project does not propose, nor will result in, a displacement of substantial numbers of people or housing. Therefore there is no need to provide replacement housing elsewhere.

Based on the number of available rental housing units in Siskiyou County and the existing conditions vacancy rate (see Table 3.16-1), there are sufficient opportunities to house the projected workforce for the Proposed Project. The Siskiyou County Housing Element (Siskiyou County 2014) noted that almost 1,300 people in the county are currently in the construction trades, suggesting that should a local workforce be needed for Proposed Project implementation, there is an ample number of construction workers that currently reside within the county. As noted in Table 2.7-13, average workforce and peak workforce for the four-month duration of construction activities that would occur simultaneously on all three dams would be 105 and 175 workers, respectively. This represents a short-term, 0.4 percent increase of the County population and would be comparable in size to the reduction of use during construction activities at the recreational facilities surrounding the reservoirs (see comparison in Section 3.22.5 *[Transportation and Traffic] Potential Impacts and Mitigation*).

Existing housing currently owned and maintained by PacifiCorp would be removed as part of the Proposed Project, but this would no longer be needed to maintain the dam facilities (Appendix B: Definite Plan).

Aside from the PacifiCorp housing associated with the dam facilities, implementation of the Proposed Project would not displace existing housing within the Area of Analysis. The potential effects of the Proposed Project on housing are limited to the need for an additional temporary worker population during construction activities and their potential need for housing. As existing vacancy rates (see Table 3.16-1) are relatively high, and there are an ample number of construction workers that currently reside within the county, there would not be a need to displace existing residents due to construction activities. The loss of the residences PacifiCorp currently owns would not create a need to build replacement housing elsewhere. As a result, there would be no significant impact.

Significance

No significant impact

3.16.6 References

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U.S. Census Bureau. 2017. 2017 Population Estimates. https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk [Accessed December 2018].

3.17 Public Services

This section describes the environmental setting for public services as well as potential environmental impacts to public services and associated mitigation measures under the Proposed Project.

For a discussion of other resource topics associated with public services, see Section 3.8 *Water Supply/Water Rights*, Section 3.10 *Greenhouse Gas Emissions*, Section 3.20 *Recreation*, Section 3.21 *Hazards and Hazardous Materials*, and Section 3.22 *Transportation and Traffic*.

The State Water Board received a comment expressing concern about there being a single access route to the Copco Dam area and the potential impacts of construction activities or traffic on the safety of other road users such as school busses, residents, pedestrians, livestock, and dogs. The comment also noted that the road could be damaged during construction activities. The State Water Board also received comments expressing concern related to how fire suppression efforts will be impacted and whether there would be a replacement plan for loss of the reservoirs. The State Water Board did not receive any other comments related to public services during the NOP public scoping process (see Appendix A).

3.17.1 Area of Analysis

The Area of Analysis for public services includes lands within the Project Boundary (Figure 2.2-4). This area includes the area in the immediate vicinity of Copco No. 1, Copco No. 2, and Iron Gate dams and reservoirs, and areas identified as construction/demolition and staging areas. The construction/demolition and staging areas are described in specific detail in this EIR in Section 2 *Proposed Project* and in Sections 5.3, 5.4, and 5.5 of Appendix B: *Definite Plan*. Consideration of public services also includes considering routes that would be used by public service providers, which are analyzed under Section 3.22 *Traffic and Transportation*.

3.17.2 Environmental Setting

The following section describes the environmental setting for public services, including fire protection, police protection, schools, and parks, among others.

3.17.2.1 Fire Protection

The Governor's Office of Emergency Services (CalOES) coordinates preparedness for and response to natural disasters, including fires, by activating the California Standardized Emergency Management System (SEMS) used by all California public safety agencies. Siskiyou County has a cooperative fire protection agreement with the California Department of Forestry and Fire Protection (CALFIRE). The cooperative agreement also includes: 29 Communities, 14 Fire Safe Councils, 30 Local Fire Departments, Siskiyou County Wildfire Protection Panel (including a county natural resources specialist, representatives from CALFIRE, USDA Forest Service, and other public members), Siskiyou County Board of Supervisors, CALFIRES's Siskiyou Unit Fire Prevention Bureau (including a Battalion Chief, two fire captains, and a Fire Prevention Specialist II), Volunteers in Prevention, Siskiyou County Arson Team, The California Conservation Corps, and the College of the Siskiyou Fire Program (CALFIRE 2015).

There are nine incorporated cities in the county that are responsible for fire protection within their respective cities: Yreka, Fort Jones, Etna, Weed, Mt. Shasta, Dorris, Dunsmuir, Montague, and Tulelake. Each fire protection service, mostly staffed by volunteers, is able to respond to a variety of emergency situations, including wildland fires, structure fires, earthquakes, search and rescue, civil disturbance, and hazardous materials incidents (CALFIRE 2015).

A discussion of emergency response to natural and man-made disasters can be found in Section 3.21 Hazards and Hazardous Materials and Section 3.22 Transportation and Traffic. An analysis of the loss of the reservoirs for firefighting purposes is included in Potential Impact 3.17-2 as well as Section 3.21 Hazards and Hazardous Materials. Water supply, in general, is included in Section 3.8 Water Supply/Water Rights.

The CALFIRE Siskiyou Unit serves Siskiyou County and covers more than 6,347 square miles (4,062,080 acres), with primary wildland fire responsibility for 1,269,672 acres. The CALFIRE Siskiyou Unit is comprised of 30 local fire departments and is active in local community outreach programs and public safety messages. The CALFIRE Siskiyou Unit suppression resources, at the peak of firefighting preparedness, included approximately 70 career personnel and 120 seasonal personnel (CALFIRE 2015).

The CALFIRE Siskiyou Unit has an Emergency Command Center known as the Yreka Interagency Command Center. The Yreka Interagency Command Center is located at the CALFIRE Siskiyou Unit Headquarters in Yreka and is a collaboration of CALFIRE and USDA Forest Service staff. The Yreka Interagency Command Center provides dispatching services for CALFIRE, USDA Forest Service, 30 local government departments, and five ambulance companies, most service the greater area of Siskiyou County. The Yreka Interagency Command Center is responsible for emergency call taking, dispatching, and tracking resources (CALFIRE 2015).

The CALFIRE Siskiyou Unit is divided geographically into four fire battalions: Battalion 1 – Scott Valley Battalion; Battalion 2 – Shasta Valley Battalion; Battalion 3 – Butte Valley Battalion; and Battalion 4 – McCloud Battalion. The Area of Analysis is located within the Shasta Valley Battalion region and is approximately 484,018 acres, with 376,598 acres designed as State Responsibility Area and 53,420 acres designated as Local Responsibility Area. The remaining area (54,000 acres) is designated Federal Responsible Area, generally within the Klamath National Forest and BLM lands. The Shasta Valley Battalion partners with 11 agencies, 10 Fire Safe Councils, 12 Siskiyou County Fire Departments within or bordering the Shasta Valley Battalion, and 11 cities and communities to: 1) reduce the total number of fires in the Battalion; 2) reduce the impact of large, damaging fires in the Battalion; and 3) reduce the number of campfire escapes (CALFIRE 2015).

The Shasta Valley Battalion consists of two CALFIRE stations: one in the City of Yreka and one in the community of Hornbrook. Both stations are open year round for fire permit issuance and other public services. The CALFIRE Siskiyou Unit headquarters, located at the Yreka Station, houses two Type III fire engines and one Type II dozer, the Hornbrook Forest Fire Station houses two Type III fire engines. The Hornbrook Station is located along the Interstate 5 near the California and Oregon border in Hornbrook and is committed to year round fire protection due to a contract with Siskiyou County. Paradise Craggy Lookout serves as the fire lookout for the Shasta Valley Battalion and is only staffed with emergency workers during high fire danger days and during and after lightning storms (CALFIRE 2015).

The closest fire department to the public services Area of Analysis is Copco Lake Fire Department, which is located at the easternmost end of Copco Lake. There are 12 volunteer firefighters staffed at the Copco Lake Fire Department (Copco Lake Fire Department 2017).

Fire hazards, including wildfires, are discussed in Section 3.21 Hazards and Hazardous Materials.

3.17.2.2 Police

The Siskiyou County Sheriff's Department provides law enforcement services to the unincorporated portions of Siskiyou County and is headquartered in Yreka, with substations in Dunsmuir, Mount Shasta, Etna, Happy Camp, Dorris, Hornbrook, McCloud, and Montague (Police Department 2017). The Sheriff's Department also contracts with cities, to help with operations (Siskiyou County 2017a).

The Enforcement Division of the Sheriff's Department is the division that contains patrol functions, detective functions, civil functions, search and rescue functions, and administrative functions (Siskiyou County 2017b). The Siskiyou County Sheriff's Department's Civil Office is located in Yreka. The closest Sheriff's station to the public services Area of Analysis is the Hornbrook Station, located at 22012 G Street in Hornbrook (Siskiyou County 2017c).

The California Highway Patrol is responsible for law enforcement on State and Federal highways in the Area of Analysis. There are two major thoroughfares that transverse the area, Interstate-5 and US 97. In addition, area patrols include State Route (SR)-3, SR-96, SR-139, SR-161, SR-263, SR-265, and hundreds of miles of unincorporated county roads. The main office for this region, which includes a communications center, is located in Yreka (CHP 2017a). The Yreka Communications Center dispatch area encompasses all of Siskiyou County, and parts of Modoc and Shasta counties. The Yreka Communications Center dispatches for: the Yreka and Mt. Shasta area offices; and the Dunsmuir Grade Commercial Vehicle Enforcement Facility (CHP 2017b). The Yreka Communications Center and the Yreka Area Office are located at 1739 South Main Street, Yreka, CA 96097 (CHP 2017b).

3.17.2.3 Medical Services

No Medical Services are provided directly within the Area of Analysis for public services. The closest Medical Services are provided at Fairchild Medical Center, which is located in Yreka, 20.2 miles from the Copco community (FMC 2017). The second closest medical facility is the Butte Valley Health Center, located in Dorris (BVHC 2017). The Butte Valley Health Center is 33.2 miles from the Copco community. The closest two hospitals nearby, include: Asante Rogue Regional Medical Center, located in Ashland, OR (ARRMC 2017), 47.7 miles from Copco, CA; and Sky Lakes Medical Center, located in Klamath Falls, OR (SLMC 2017), 51.8 miles from Copco, CA.

3.17.2.4 Schools

The Siskiyou County Office of Education oversees the school districts and educational programs to, “provide quality assistance and resources to schools as they deliver equitable learning opportunities for all students and provides a menu of powerful services to schools and communities supporting the learning goals of each child and family” (SCOE 2017a).

Siskiyou County has several charter schools, elementary schools, high schools, alternative education schools, and community day schools (SCOE 2017b). Yreka is served by the Yreka Union Elementary School District and the Yreka Union High School District. Bogus Elementary, Hornbrook Elementary, Willow Creek Elementary, Meadows Union Elementary, Little Shasta Elementary, and Montague Elementary are close to the Area of Analysis (Great Schools 2017).

Bogus Elementary School is the closest school to the public services Area of Analysis. It is 5.4 miles east of the Iron Gate Dam (Google Maps 2017a), and 5.3 miles southeast of Copco Dam No.1 and No.2 (Google Maps 2017b).

Bogus Elementary School is a K-8 grade, two-room school with a current enrollment of 14 students. There is one full-time teacher/principal/superintendent, one full-time instructional aide who additionally serves as part-time bus driver and part-time cafeteria coordinator/cook (Bogus Elementary School 2017). Bogus Elementary School is located at 13735 Ager-Beswick Rd., Montague, CA 96064-9434.

3.17.2.5 Parks, Park Facilities, and Other Public Facilities, including the Existing Reservoirs

The Area of Analysis for public services contains a number of recreational facilities that currently are well used primarily during the summer months. The reservoirs associated with the Lower Klamath Project, three of which are in California, could be considered public facilities. These park and other facilities are described in Section 3.20 Recreation.

3.17.3 Significance Criteria

Criteria for determining significance for public services are based on Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and professional judgment. Effects on public services are considered significant if the Proposed Project would result in one or more of the following conditions or situations:

- Substantially increase public service response times for emergency fire, police, and medical services due to construction and demolition activities.
- Eliminate a long-term water source for wildfire services, and the associated increase in response times.
- Create a substantial adverse effect on schools services and facilities.

3.17.4 Impact Analysis Approach

The approach to the impact analysis for public services focuses on whether the Proposed Project will result in impairing existing public services or create a need for increased services related to fire, police, or medical facilities. The long-term effects of the Proposed Project would result in elimination of a long-term water source for wildfire services (e.g., the reservoirs) and the associated increase in response times. Otherwise, the long-term effects of the Proposed Project would be a reduction in hydropower operation activity and existing recreation, which could reduce the risk and need for emergency services, as a result of reduced traffic from those uses. Whether future land uses will create traffic that would meet or exceed the existing condition is, at this point, speculative. The Proposed Project, the removal of the four dams and associated facilities, will also not create a long-term need for additional school services or facilities.

This analysis includes a focus on short-term construction-related activities. Analysis of peak construction-related activity recognizes that other Project-related activities, including those that will occur prior to and following peak periods, would result in less of a potential impact because the risk of the need for emergency services is reduced with less use occurring in the area. The following analysis and referenced mitigation measures included for the peak construction-related activities would also be relevant to non-peak activities. These potential impacts would be considered short-term impacts. The analysis for the adequacy of public services for the Proposed Project is further addressed in several other sections including Section 3.21 Hazards and Hazardous Materials and Section 3.22 Transportation and Traffic.

Potential impacts related to maintaining acceptable service ratios, response times, or other performance objectives for any of the public services during the construction-related activities would be dependent on the Proposed Project's forethought in providing an Emergency Response Plan, Fire Management Plan, Traffic Management Plan (Traffic Management Plan), and Hazardous Materials Management Plan (Hazardous Materials Management Plan). These have been included in Appendix B: Definite Plan – Appendices O1 – O4. Mitigation measures have been added in Section 3.21 Hazards and Hazardous Materials and Section 3.22 Transportation and Traffic to address these concerns.

Finally, the analysis addresses whether the Proposed Project will impact school services or facilities during the period of activity for the Proposed Project. The effect on parks, park facilities, and other public facilities, including the existing reservoirs is analyzed in Section 3.20 Recreation.

3.17.5 Potential Impacts and Mitigation

Potential Impact 3.17-1 Increased public services response times for emergency fire, police, and medical services due to construction and demolition activities.
The Proposed Project could result in a significant impact if it results in substantial increases in emergency response times within the Area of Analysis. In general, development of an adequate Traffic Management Plan (Traffic Management Plan) would mitigate the potential short-term impacts of construction-related traffic and therefore minimize changes to public service response time. Under the Proposed Project, demolition and construction areas would be closed off to the public to reduce hazards. Due to the rural nature and low concentration of roads in the area, most existing roads are currently used, and would continue to be used, by emergency responders and for evacuation routes in the event of fire or other emergencies. The use of these roads for construction activities could interfere with emergency response and evacuation. The potential for substantial interruptions to road access for property owners within the public

services Area of Analysis during construction activities would not be a significant impact since alternative routes are or would be made available as part of the proposed Traffic Management Plan (Traffic Management Plan) (Section 3.22 *Transportation and Traffic*). The KRRC's Traffic Management Plan is a specialized program tailored to minimize impacts by applying a variety of techniques such as *Public Information, Motorist Information, Incident Management and Construction Strategies.* The major objectives of the Traffic Management Plan are to maintain efficient and safe movement of vehicles through the construction zone covered by activities in the Definite Plan and to provide public awareness of potential impacts to traffic on both haul routes and access roads to the four dams and associated facilities. The Traffic Management Plan outlines the structure and key requirements that would be incorporated by the KRRC's contractor into a final Traffic Management Plan. The final Traffic Management Plan would be informed by KRRC's contractor's specific means and methods for construction, which could refine the approach to access and traffic management. KRRC proposes that the final Traffic Management Plan would meet applicable regulatory permit requirements, as well as applicable state and local ordinances, as appropriate (Appendix B: *Definite Plan – Appendix O2)*.

Construction activities would involve staging and stockpiling areas and equipment that would be kept on-site for the duration of construction. The Limits of Work (Figures 2.7-2 and 2.7-4) would include activities that may result in accidental spills of flammable liquids or use of equipment that generates heat, such as welding, grinding, torch-cutting, gas and diesel generators. Other construction activities could result in open sparks or flame in vegetated open space that could further aggravate the risk of fire. Emergency and Security services would be provided by the construction contractor, therefore the Proposed Project would not increase the need for emergency services or the number of emergency responders. What is important for the reduction of impacts is that all construction workers have the knowledge and resources to respond to emergencies and all emergency preparation and work are overseen by a designated health and safety manager, which is proposed as part of the Proposed Project. In addition, the Proposed Project (Appendix B: *Definite Plan*) proposes that responding agencies and departments are made aware of the activities during the construction period so that they can implement their existing regulatory framework, establish an emergency contact process, and include inspections as needed throughout the process.

Mitigation Measure HZ-1 and Recommended Measure TR-1 would reduce the potential impacts related to construction activities since these measures require that the KRRC and its contractor(s) for the Proposed Project submit the additional documentation/details included in the final Emergency Response Plan, Fire Management Plan, Traffic Management Plan, and a Hazardous Materials Management Plan, and they work with applicable agencies prior to the start of construction. Implementation of these two measures would reduce the potential for a short-term increase in personal and public health and safety risks due to the Proposed Project as related to emergency response services. There would be no long-term impacts due to the Proposed Project construction-related activities since the construction would be completed in the short term.

Most of the roads within the Area of Analysis are currently owned or managed by PacifiCorp (Section 3.22.2.3 *Road Conditions*). PacifiCorp would continue to own and manage the roads contained within Parcel A and KRRC would own and manage the roads contained in Parcel B (see Figure 3.14-4). Section 3.21 *Hazards and Hazardous*

Materials discusses the transport of hazardous materials, emergency, and wildfire potential and includes Mitigation Measure HZ-1 to address potential impacts to emergency response under the Proposed Project. As discussed in Section 3.22 *Traffic and Transportation*, the Proposed Project also includes an Emergency Response Plan. Recommended Measure TR-1 includes coordination between the Traffic Management Plan and Emergency Response Plan and additional detail necessary to reduce impacts.

Overseeing development and implementation of the final Traffic Management Plan and final Emergency Response Plan does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to reach enforceable good citizen agreements that will be finalized and implemented, at this time the Traffic Management Plan and Emergency Response Plan are not finalized and the State Water Board cannot require their implementation. Accordingly, the State Water Board anticipates that implementation of the final Traffic Management Plan and Emergency Response Plan, including the additional details in Recommended Measure TR-1 and any modifications developed through the FERC process that provide the same or better level of protection for transportation and traffic would reduce impacts to less than significant. However, because the State Water Board cannot ensure implementation of the final Traffic Management Plan and final Emergency Response Plan, it has determined the impact in this Draft EIR to be significant and unavoidable**.**

Significance
Significant and unavoidable with mitigation

Potential Impact 3.17-2 The Proposed Project's elimination of a long-term water source for wildfire services could substantially increase the response time for suppressing wildfires.

The Proposed Project would result in the removal of one readily available water source for wildfire services or increased emergency response times if other sources of water are not as readily available. Under the Proposed Project, removal of the Copco No.1, Copco No. 2, and Iron Gate reservoirs would remove a long-term water source for fire suppression crews after the reservoirs are removed. The removal of the reservoirs could increase turn-around time for helicopters or ground crews refilling with water for fire abatement purposes. However, the initial response times for existing aircraft with fire retardant would not be changed by the loss of the reservoirs. Following dam removal, helicopters and ground crews would still be able to extract water from the Klamath River (both the current channel and the channel reaches to be exposed in the current reservoirs following drawdown), Lake Ewauna, and Upper Klamath Lake. Retrieving water directly from the Klamath River is consistent with how wildfires are suppressed along the Klamath River downstream of Iron Gate Dam under current conditions.

With respect to Klamath River access, most helicopter water tanks require three feet of water depth to fill properly, so only deeper pools in the Klamath River would be able to be used by helicopters. CALFIRE uses the closest available water source that is suitable for fire-fighting, where suitability is determined by local conditions including water flow, depth of pool (2- to 3-foot minimum), amount of debris in pool, shoreline vegetation, and surrounding terrain. Rotor blade length and the length of bucket lines are also determinants, since there must be a safe amount of space to enter and exit the pool site. Individual pilots use their discretion to determine the closest and safest locations from which to withdraw water.

Analysis of aerial photos (Google Maps 2018) suggests the presence of pools with suitable conditions for helicopter filling in the currently free-flowing reaches of the Middle and Upper Klamath River, particularly in the reaches between Copco No. 1 and J.C. Boyle reservoirs and downstream of Iron Gate Dam. While source water would be available in the Klamath River in pools located in the river reaches exposed following reservoir drawdown, the travel time involved in accessing the newly formed pools would be greater than that for the existing Lower Klamath Project reservoirs because retrieval of water from relatively smaller, more narrow, river pools is more difficult than dipping directly from the broad water surface of a lake or reservoir, and only one helicopter at a time would have access to a given river pool versus multiple helicopters that can draw at one time from a large reservoir. Thus, response and travel times between water fills for helicopter crews would be expected to increase with the loss of the reservoirs. Wildfires can spread at a rapid speed, and involve high risks. Any amount of additional response time compared with existing conditions could result in a substantial increased risk of loss, injury, or death involving wildland fires and this would be a significant impact.

To compensate for the loss of reservoir water supply, the Proposed Project includes providing alternate water supply through dry hydrants that would be accessible to ground crews following removal of the dams. Flows in the Klamath River and tributaries are not expected to substantially change post-dam removal, as compared to current flows, and firefighting ground crews could still use the river as a water supply as long as physical access to water is provided. Dry hydrants are passive, unpressurized systems, with a screened intake placed in the channel above the channel bed. An above-ground fire hose is used to connect the intake to truck-mounted pumps (Figure 3.17-1). Placement of the dry hydrant must be in a location of satisfactory depth (during dry conditions), flow rate, and channel stability. The Definite Plan states that dry hydrants are commonly used as water supply for fighting fires in rural areas, and typical dry hydrants and fire truck pumps can supply over 1,500 gallons per minute, which is sufficient for rapid filling of typical water tankers and firefighting apparatus (Appendix B: *Definite Plan – Appendix O1*).

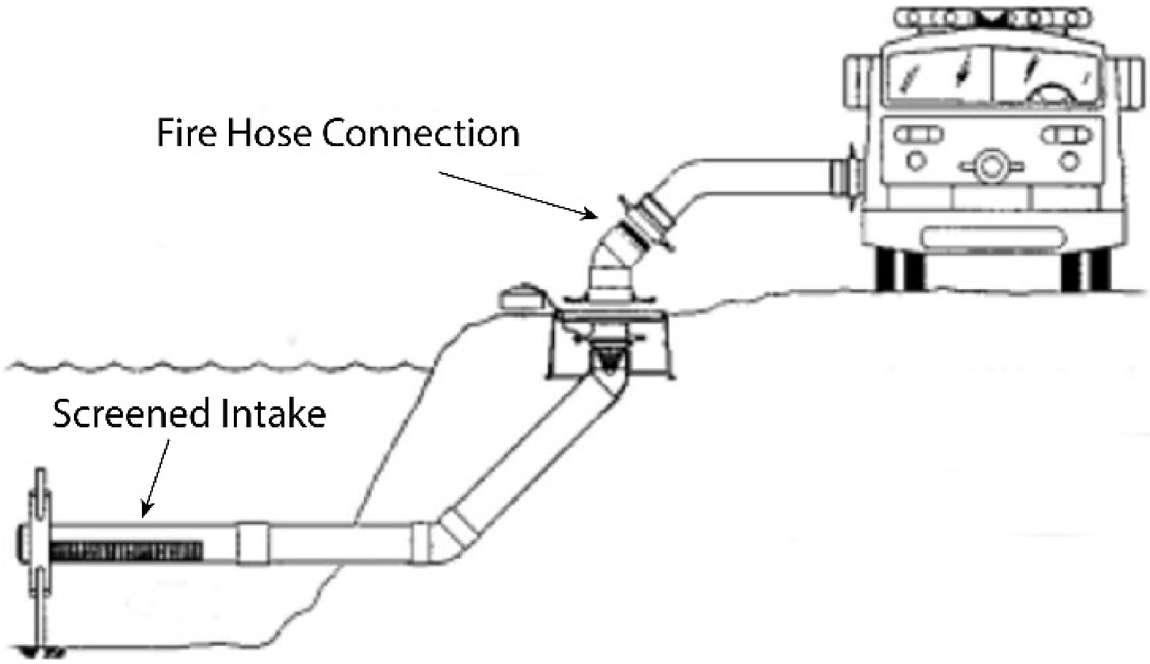

Figure 3.17-1. Diagram of Typical Dry Hydrant System.

Potential dry hydrant sites located within PacifiCorp or state-owned property boundaries that leverage existing, permanent infrastructure (e.g., fire stations, bridges, roads, and boat launches), would offer proximity and ease of access to current or anticipated post-removal Klamath River or tributary channels. Bridges and crossings would be desirable given the increased certainty of access to water post-removal and the ability to use the structure for mounting the dry hydrant rather than excavating earthen material for pump installation.

At Copco No. 1 Reservoir and the reach of the Klamath River upstream of the reservoir, eight potential dry hydrant sites were identified (Figure 3.17-2). Access to the mainstem Klamath River upstream of Copco No. 1 Dam after removal would be limited if the channel reoccupies its historical alignment as predicted. The historical Klamath River had a meandering shape in the Copco No. 1 Reservoir, and the mainstem would likely be either far from existing roads or difficult to access due to the presence of steep, high relief bluffs particularly near the Copco No. 1 Dam site.

Potential dry hydrants at Copco No. 1 Reservoir are labeled CP1 through CP8. CP1 would be located along Copco Road adjacent to where Beaver Creek would be expected to run post-removal, but, with sufficient flow, could be moved to where Copco Road crosses Beaver Creek upstream of the confluence with East Beaver Creek. CP2 would be located along the historical Klamath River and Copco Road downstream of Raymond Gulch at a location where the valley topography is less steep. CP3 would be located near the historical confluence of the Klamath River and Deer Creek off Patricia Avenue, close to Copco No. 1 Reservoir Fire Station. CP4 would be sited where Ager Beswick Road crosses Deer Creek. CP5 would be located at the Copco Road bridge over the Klamath River at the eastern margin of the reservoir adjacent to the Copco Lake Fire Department Station A. CP6 would be located on a bridge over the Klamath River upstream of the current influence of Copco 1 Dam, accessible off Ager Beswick Road.

CP7 would be located on a small bridge over the Klamath River off Ager Breswick Road and immediately upstream of the Shovel Creek confluence. CP8 would be located at a fishing access area off Ager Breswick Road where a rapid holds grade to maintain a deeper pool for water extraction.

At Iron Gate Reservoir, four potential dry hydrant locations were identified and labeled IG1 through IG4 (Figure 3.17-3). IG1 would be sited at the Lakeview Road bridge crossing over the Klamath River, downstream of Iron Gate Dam and adjacent to the Iron Gate Hatchery. IG2 would be located in the vicinity of the Camp Creek campground where Copco/Iron Gate Lake Road crosses Camp Creek. IG3 would be located at the bridge where Copco/Iron Gate Lake Road crosses Jenny Creek. IG4 would be sited where the Daggett Road bridge crosses the Klamath River, adjacent to the Fall Creek confluence and Copco/Iron Gate Lake Road.

The proposed dry hydrants are likely to be of limited use for firefighting compared with existing conditions because only ground crews can access them (i.e., they are of no use to aerial crews that can access the reservoirs under existing conditions). Hook-ups to the dry hydrants would require standardized equipment for all vehicles and existing CALFIRE pumper trucks would require special equipment such as hard suction lines (a flexible hose would collapse) to successfully draft from the dry hydrants. The ground crews would need to be able to get close to the river to draft from the dry hydrants because fire trucks typically can only lift water over short vertical distances (i.e., 10 to 14 feet, with a maximum 15-foot height from the intake) and drafting from bridges may require too much lift. Decreased response time associated with dry hydrants as compared with aerial crew access of reservoir water via helicopters would be a significant impact since it could increase the risk of loss, injury, or death involving wildland fires. Direct withdrawal from the river using a boat ramp, pumping stations equipped with pumps connected to wells or deep pools in the river, above-ground storage tanks with ready access for transferring water to pumper trucks, are likely to be better options than the dry hydrants proposed by KRRC because these alternatives would be easier to use and thus would reduce ground crew response time.

In the long term, the loss of the reservoirs, which are currently part of the existing conditions, would result in a substantial decrease in fire protection involving wildland fires due to longer response times and limitations on access to Klamath River water for fighting fires within the Area of Analysis for public services. While the proposed dry hydrants would provide a source of water to ground crews for firefighting, they do not offer the same degree of access as helicopter use of the reservoirs for wildfires occurring in the vicinity of the Lower Klamath Project, for which the reservoirs are the closest and safest source of water for aerial crews. One option that would assist in mitigating this impact would be to include appropriately placed dip ponds within the Proposed Project's restoration areas.

Recommended Measure PS-1 requires the KRRC and/or its Contractor(s) to develop, in consultation with the CALFIRE Siskiyou Unit, an updated Fire Management Plan that identifies long-term water sources for helicopter and ground crews (including construction and use of proposed dry hydrants, dip ponds, or other alternatives). Updating the CALFIRE Siskiyou Unit's Fire Management Plan with available sources of water for helicopters and ground crews following dam removal provides new information to support fire services in the absence of the reservoirs. The State Water Board anticipates that in the absence of the reservoirs, the identification and use of alternative water sources (e.g., dip ponds, river pools suitable for helicopter drafting, dry hydrants) for both ground and helicopter crews that are developed through the FERC process would significantly ameliorate response times and provide a level of protection to substantially reduce the public's risk of loss from wildfires, thereby reducing impacts to less than significant in many instances. However, where suitable replacement water sources cannot be identified in close proximity to a fire in a location for which the reservoirs would otherwise have been the nearest water source, long-term impacts to the public's risk of loss from wildfires remain significant and unavoidable.

Additionally, the terms of an updated Fire Management Plan and its incorporation of Recommended Measure PS-1 are not within the State Water Board authority, and the State Water Board therefore cannot ensure implementation of this measure. Thus, the State Water Board has determined the long-term impact in this EIR to be significant and unavoidable.

Recommended Measure PS-1 – Fire Management Plan.
The KRRC and/or its Contractor(s) shall develop a post-dam removal Fire Management Plan in consultation with the CALFIRE Siskiyou Unit. The Fire Management Plan shall identify long-term water sources for helicopter and ground crews (including construction and use of proposed dry hydrants, dip ponds, or other alternatives). After reaching agreement on the Fire Management Plan with CALFIRE Siskiyou Unit, the KRRC and/or its Contractor(s) shall submit the Final Fire Management Plan to the CALFIRE Siskiyou Unit and implement any portions of the plan for which the KRRC has identified responsibilities.

Significance
Significant and unavoidable

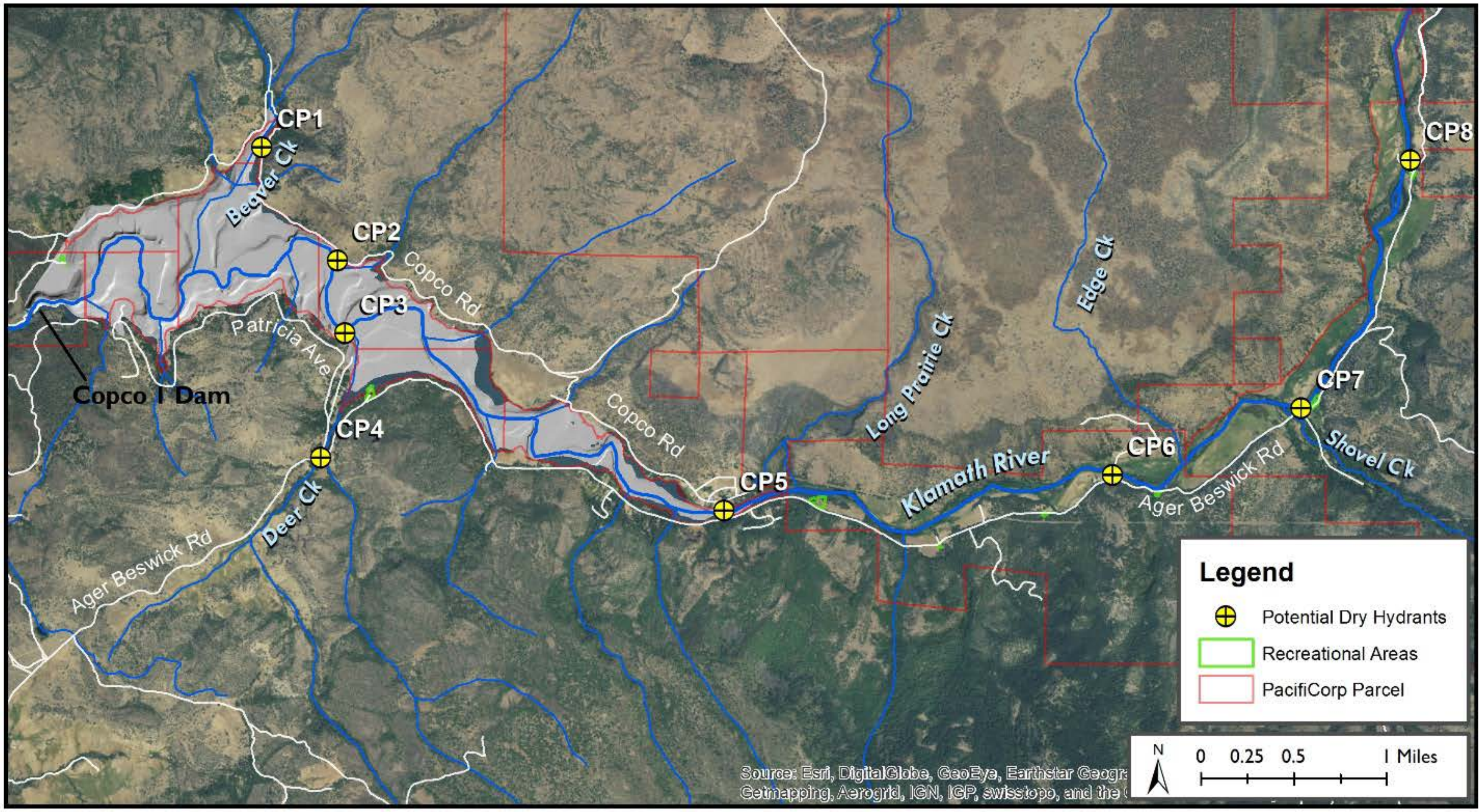

Figure 3.17-2. Locations of Potential Dry Hydrants for Copco No. 1 Reservoir.

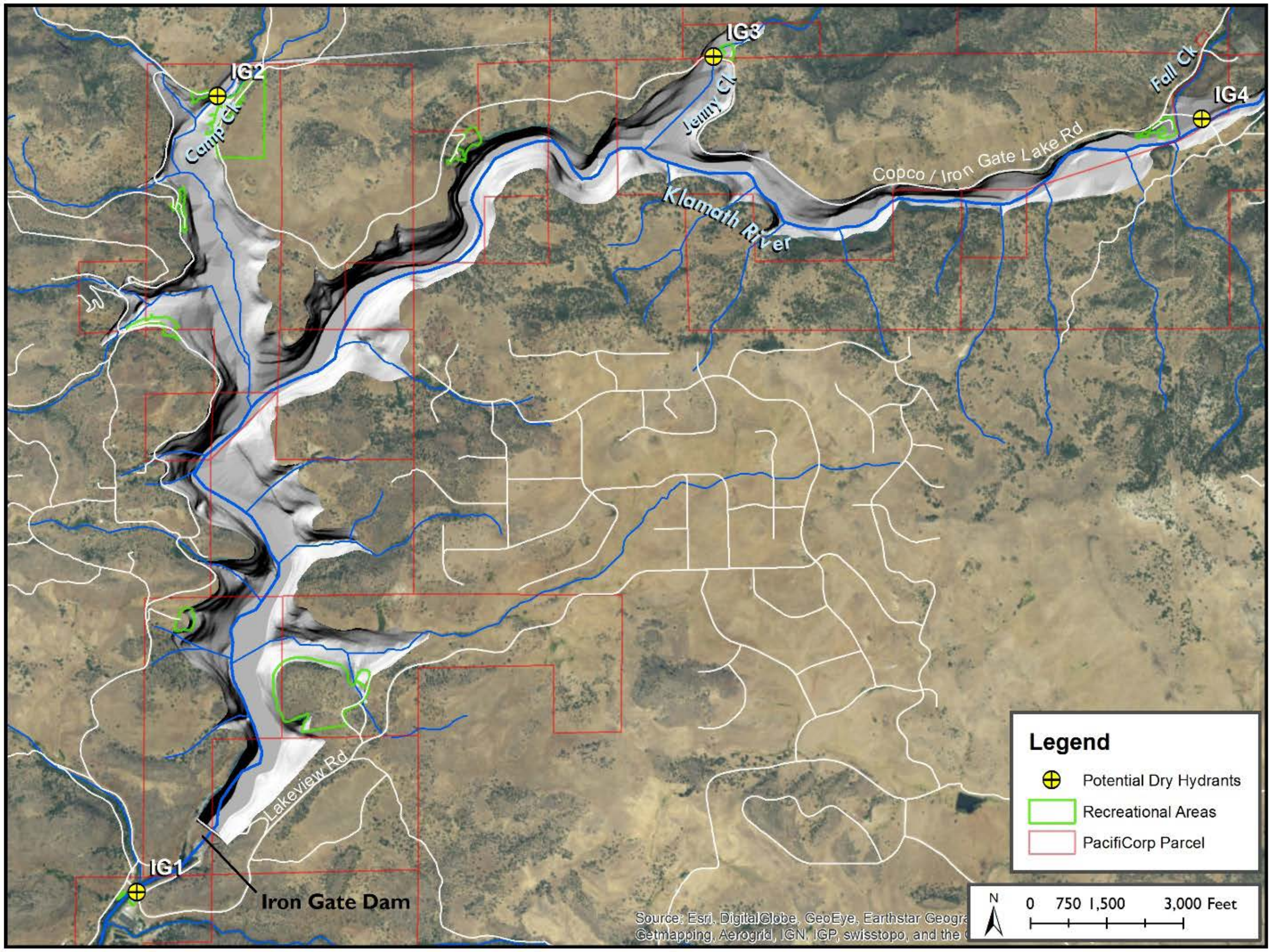

Figure 3.17-3. Locations of Potential Dry Hydrants for Iron Gate Reservoir.

Potential Impact 3.17-3 Potential effects on school services and facilities.
In the short term, Proposed Project construction activities could result in adverse effects on school services or facilities if it results in increased student enrollment that exceeds the capacity of the nearby schools. While the Proposed Project could have short-term impacts to school facilities and services during the construction period if a number of construction workers move into the area during the construction period, related impacts would be speculative as the contracting firms have not been selected. According to the Proposed Project schedule (Table 2.8-1), peak construction-related activity would primarily occur when school would not be in session. Therefore, the Proposed Project would not result in short-term impacts to school services and facilities.

In the long term, the Proposed Project does not have the potential to affect schools in terms of additional students or longer bus routes, nor would it generate the need for additional classrooms or school services. The removal of PacifiCorp housing related to the Lower Klamath Project dams and associated facilities may reduce the need for school facilities, depending on the occupancy of its residences. However, since the number of residences is small (i.e., one occupied residence at Copco No. 1 and No. 2 dams and two occupied residences at Iron Gate Dam), there would be no impact on school services and facilities due to the Proposed Project in the long term.

Significance
No significant impact

3.17.6 References

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3.18 Utilities and Service Systems

including wastewater, stormwater, and solid waste, as well as potential environmental impacts to utilities and service systems due to implementation of the Proposed Project. Additional information related to utilities and service systems is discussed in Section 3.8 *Water Supply and Water Right*s, 3.21 *Hazards and Hazardous Materials*, and 3.22 *Transportation and Traffic*.

The State Water Board received several comments during the NOP public scoping process regarding potential impacts to Yreka's municipal water supply and the need to realign the water supply pipeline as part of dam removal. These issues are addressed in Section 3.8 *Water Supply/Water Rights*. The State Board also received comments regarding Clean Energy Sources and resulting lower utility rates. These issues are addressed in Section 3.10 *Greenhouse Gas Emissions*. The State Water Board did not receive any other comments related to utilities and service systems. The summary of comments received during the NOP public scoping process, as well as the individual comments themselves, are presented in Appendix A.

3.18.1 Area of Analysis

The Area of Analysis for utilities and service systems includes lands within the Project Boundary (Figure 2.2-4). The Area of Analysis for solid waste also includes consideration of disposal capacities for accommodating solid wastes at the Yreka Transfer facility near Hornbrook, CA, the Class 1 Landfill near Anderson, CA, and the Dry Creek landfill site in White City, OR., even though these areas are not shown as part of the Project Boundary.

3.18.2 Environmental Setting

The following section describes the environmental setting for utilities and service systems that could be affected by implementing the Proposed Project.

3.18.2.1 Wastewater

Siskiyou County does not provide wastewater treatment within the Area of Analysis for utilities and service systems. Generally, sewer and septic facilities are offered by local municipalities (SCEDC 2018). Yreka has one wastewater treatment plant that treats and disposes of both domestic and industrial sewage generated within the city's boundaries (City of Yreka 2018). The facility is designed to accommodate up to 1.3 million gallons per day (mgd) of average dry weather flow. Yreka's General Plan reported that average dry weather flow in 2003 was between 0.7 and 0.9 mgd (City of Yreka 2003).

All the communities in unincorporated areas of Siskiyou County, including the rural communities of Hornbrook and Copco Village, have a community wastewater treatment system, onsite septic systems (USBR 2012), or have arranged to use an adjacent city's wastewater treatment facilities. There are five community service districts that meet the demands for sewer and wastewater treatment in Siskiyou County (SCCDD 2014); these are all located outside of the Area of Analysis. The Area of Analysis is served by individual sewage disposal systems (i.e., septic tanks). These are allowed within unincorporated Siskiyou County through permits with the Siskiyou County Public Health

Department (PacifiCorp 2015). The Siskiyou County Public Health Department applies the Sewage Disposal Code to any new construction, alterations, repairs, reconstruction and removal of individual sewage disposal systems within the unincorporated areas of Siskiyou County (Siskiyou County 2018a).

Recreational facilities located along the shoreline of Copco No.1 and Iron Gate reservoirs have installed vault toilets (i.e., enclosed toilets that require periodic removal of waste generated) that are serviced routinely during usage periods with pumper trucks. The trucks discharge the collected wastewater into Yreka’s sewer system or other permitted facility.

The Proposed Project will require the use and maintenance of portable chemical toilets on site during construction activities. The quantity is determined by the number of workers.

3.18.2.2 Stormwater

Stormwater is managed by the individual municipalities within Siskiyou County. However, no municipal stormwater systems are located within the Area of Analysis for utilities and service systems. Stormwater captured by impervious surfaces at existing Lower Klamath Project facilities and the local communities of Hornbrook and Copco Village is conveyed by natural drainages. The Lower Klamath Project facilities do not have any stormwater disposal systems (FERC 2004).

3.18.2.3 Water Supply

The Proposed Project Area of Analysis is in an unincorporated area of Siskiyou County and is not served by any water district. Water supplies are provided to rural residences near the Lower Klamath Project facilities by private groundwater wells (USBR 2012). Additional information about surface and groundwater is described and analyzed in Section 3.7 *Groundwater* and 3.8 *Water Supply/Water Rights*.

3.18.2.4 Solid Waste

Solid waste in Siskiyou County is handled by the County’s General Services Sanitation Division which provides a fee-based solid waste disposal system for the entire county. The county operates five recycling and transfer sites: Black Butte Transfer Station, Happy Camp Transfer Station, Salmon River Area Collection Facility, Tulelake Transfer Station, and Yreka Transfer Facility (Siskiyou County 2018b). The Proposed Project site is within the jurisdictional boundaries of the Siskiyou County Integrated Solid Waste Management Regional Agency (CalRecycle 2018).

The Siskiyou County Source Reduction and Recycling Element (SRRE) establishes goals and methodologies for compliance with California AB 939, which establishes 50 percent diversion of solid waste from landfills. In 2017 CalRecycle found the County to be in substantial compliance with AB 939. The County regulates garbage and refuse disposal through the Siskiyou County Solid Waste Ordinance. (Siskiyou County 1963).

The Proposed Project proposes to dispose of solid waste at the County transfer station at the former landfill site on Oberlin Road, located two miles southeast of Yreka, California, which is the nearest transfer station that could be used for recycling and waste disposal/transfer during dam demolition. The transfer station is permitted to accept general residential, commercial, and industrial refuse for disposal, including municipal solid waste, construction and demolition debris, green materials, and agricultural debris. The Yreka Transfer Facility has a capacity of 100 tons per day. Currently, solid waste is transferred approximately 45 miles from the Yreka Transfer Facility to the Dry Creek Landfill facility near White City Oregon. In 2018 this facility had a total capacity of 76,800,000 tons with a life projected at over 100 years (Dry Creek Landfill 2018).

Hazardous materials, including batteries, paints, treated wood waste, and other hazardous materials, must be disposed at certified Class I landfill facilities, which are lined to prevent the contamination of underlying soils and groundwater. The Anderson Landfill in Anderson, California, is located 122 miles south of Hornbrook, California, and is permitted to accept hazardous waste. The Anderson Landfill had an estimated remaining capacity of 11,914,025 cubic yards (72 percent of capacity remaining) in 2008, with an anticipated closure date of 2055 (CalRecycle 2018). Some special wastes are also accepted at the Dry Creek Landfill facility located 45 miles north of Hornbrook, California, but they would require pre-approval prior to disposal.

Estimated quantities of solid waste are described in Section 2.7.1 *Dam and Powerhouse Deconstruction*, as well as the Definite Plan for the Lower Klamath Project (Appendix B: *Definite Plan – Tables 5.3-3, 5.4-3 and 5.5-3*), and are much less in volume than the limitations noted above, as discussed in Potential Impact 3.18-4.

3.18.3 Significance Criteria

Criteria for determining significance of potential impacts to utilities and service systems is informed by Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and based on professional judgment. Effects to utilities and service systems are considered significant if the Proposed Project would result in one or more of the following conditions or situations:

- Require or result in the construction of new wastewater treatment and/or disposal facilities or expansion of existing facilities, due to inadequate capacity to serve the Proposed Project's anticipated demand or where the construction of such facilities could cause significant environmental impacts.
- Require or result in the construction of new stormwater drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental impacts.
- Be served by a landfill with insufficient permitted capacity to accommodate the project's solid waste disposal needs.
- Violate applicable statutes and regulations related to solid waste.

3.18.4 Impact Analysis Approach

The approach to analyzing potential impacts related to utilities and service systems considers existing conditions as the baseline for utilities. Unlike many other projects, the Proposed Project would result in reduced long-term utility and services use due to the reduction of use from the operation of the dam facilities. Therefore, the majority of the impact analysis focuses on potential short-term, construction-related impacts associated with construction activities.

Of primary concern for short-term impacts is the export of solid waste from construction during construction activities before, during, and after reservoir drawdown. Short-term waste export is described in the Project Description. Hazardous material removal is analyzed in Section 3.21 *Hazards and Hazardous Materials*. Transport of hazardous materials and Section 3.22 *Transportation and Traffic*.

Water Supply is analyzed in Section 3.8 *Water Supply/Water Rights*.

Local regulations pertaining to impacts analyzed in this section include Siskiyou County General Plan policies, County stormwater regulations, onsite wastewater treatment system regulations for removal of septic systems and requirement for chemical toilets (Siskiyou County Code of Ordinance Title 5, Chapter 2 Sewage Disposal), and solid waste regulations such as the countywide Source Reduction and Recycling Element and Siskiyou County Code of Ordinance Title 5, Chapter 1 Garbage and Refuse Disposal.

3.18.5 Potential Impacts and Mitigation

Potential Impact 3.18-1 The Proposed Project could result in the construction of new wastewater treatment facilities or expansion of existing facilities, due to inadequate capacity to serve the Proposed Project's anticipated demand or where the construction of such facilities could cause significant environmental impacts. There are no municipal wastewater treatment facilities within the Area of Analysis for utilities and service systems. Siskiyou County regulates individual onsite wastewater treatment facilities (septic systems) through its Sewage Disposal Code (Siskiyou County Code of Ordinance, Title 5, Chapter 2 Sewage Disposal), implemented by the Siskiyou County Environmental Health Division.

Within the Area of Analysis for utilities and service systems, the area in which wastewater is generated includes wastewater collection facilities at recreation sites, where wastewater is pumped from vaults, then hauled to and disposed of at permitted sites (i.e., Yreka Wastewater Treatment Plant). The Proposed Project includes elimination of some of the recreational sites, resulting in removal of their wastewater facilities. As part of the removal of existing systems or for any new recreational facility proposed each facility would need to meet applicable wastewater system design requirements (i.e., Siskiyou County Code of ordinance, Title 5, Chapter 2 Sewage Disposal). Other wastewater treatment systems within the Area of Analysis consist of individual onsite wastewater treatment systems (i.e., septic systems). The septic tanks associated with PacifiCorp housing would be removed under the Proposed Project[167]. Those systems associated with surrounding residential or commercial uses would not be affected by the Proposed Project.

[167] Potential Impact 3.21-1 analyzes potential impacts due to the routine transport, use, or disposal of hazardous materials associated with the Proposed Project, including the removal and disposal of septic tanks. Additionally, note that the State Water Board has authority to review and approve any final plan developed to address removal and disposal of septic tanks through its water quality certification under Clean Water Act Section 401. The State Water Board has issued a draft water quality certification which sets forth requirements for hazardous materials management, including proper removal and disposal of septic tanks, as Condition 11.

The Proposed Project would make use of portable chemical toilet facilities during construction activities, which require providing adequate toilet facilities for work crews that are regularly cleaned, pumped, and have wastes disposed of by the toilet providers. Both County and State regulations dictate requirements for proper numbers of facilities and sanitary conditions. Based on Table 2.7-8 (workforce projections), the need for toilet facilities would be limited to the short-term (i.e., dam removal years 1 and 2) when construction activities and the number of workers (average 30 to 40) at each of the three California sites would co-occur. As closure of the existing Lower Klamath Project recreational facilities would occur prior to dam removal construction activities, there would be no overlap in recreational user wastewater generation and construction worker wastewater generation, and thus no substantial increase in the need for proper wastewater disposal at existing municipal treatment facilities due to the Proposed Project. Estimated traffic flow to recreational facilities under existing conditions is 166 visits/trips per day, compared to projected dam removal construction worker traffic flow of 105 average and 175 peak trips per day (see Potential Impacts 3.22-1 and 3.22-2). Based on these traffic flow estimates, overall construction worker requirements for toilet facilities during dam removal activities would be similar to that of recreational users under existing conditions and thus the Proposed Project would not result in the need for new treatment and/or disposal facilities or expansion of existing facilities, where the construction of such facilities could cause significant environmental impacts, and there would be no impact.

Since the total area of construction-related activities for the Proposed Project amounts to greater than one acre, the Proposed Project would be required to obtain coverage under the State Water Board Construction General Permit (2009-0009-DWQ as amended by 2010-0014-DWQ and 2012-0006-DWQ) (CGP). Each of the proposed construction areas, including staging, stockpiling, onsite disposal, and access-related areas, must be covered by the CGP. The CGP requires the applicant to address such items as employee wastewater generated during construction and spill containment and clean-up. Thus, meeting CGP requirements for onsite toilet facilities for short-term use by construction crews would not result in a significant impact as there will not be an increased need for permanent wastewater treatment facilities or an anticipated demand for additional wastewater treatment facilities.

Significance

No significant impact

Potential Impact 3.18-2 The Proposed Project could require or result in the construction of new stormwater drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental impacts.
There is no existing formal stormwater collection system in the Area of Analysis for utilities and service systems. Each of the proposed construction areas, including staging, stockpiling, on-site disposal, and access-related areas, must be covered by the CGP. This would require the applicant to address items such as erosion and sediment control, stormwater, spill prevention and containment, and site cleanup during the short-term construction period (two to three years), but would not require construction of new stormwater drainage facilities or expansion of existing facilities.

Significance

No significant impact

Potential Impact 3.18-3 The Proposed Project could exceed permitted landfill capacity to accommodate the project's solid waste disposal needs.

Potential Impact 3.18-4 The Proposed Project could violate applicable statutes and regulations related to solid waste.

The below analysis applies for both Potential Impacts 3.18-3 and 3.18-4.

Overall, the total volume of waste generated by the Proposed Project would be approximately 1.4 million cubic yards (see Table 2.7-3 for estimated quantities of waste disposal for Copco No. 1 Dam, Table 2.7-5 for Copco No. 2 Dam, and Table 2.7-7 for Iron Gate Dam). For the Proposed Project, the vast majority of waste (i.e., soil and concrete) generated by demolition of the Lower Klamath Project dam complexes would be disposed of onsite and would not require transport to a landfill, thereby providing a substantial diversion of wastes meeting the County's AB 939 requirements. The Proposed Project would make use of onsite disposal options for appropriate construction debris in keeping with applicable regulations related to solid waste disposal.

Waste material exported from the Proposed Project sites to the Yreka Transfer Station would amount to less than 15,000 cubic yards. The Yreka Transfer Station is permitted to accept up to 100 tons per day of general residential, commercial, and industrial refuse for disposal, including municipal solid waste, construction and demolition debris, green materials, and agricultural debris. Siskiyou County requires waste diversion, therefore solid wastes sent to the Transfer Facility will need to be sorted at the construction site. Volumes exceeding the daily limit of 100 tons per day will need to be hauled by the contractor, most likely to the Dry Creek Landfill, approximately 45 miles north of Hornbrook, California. The Proposed Project also would require disposal of approximately 700 tons of treated wood waste from the wooden staves at Copco No. 2 Dam, where the treated wood is considered a hazardous material. This and other hazardous materials must be disposed at facilities certified to receive them. The Anderson Landfill in Anderson, California, is located 122 miles south of Hornbrook, California, and is a Class I facility, lined to prevent contamination of underlying soils and groundwater, and permitted to accept hazardous waste, including treated wood waste. Section 3.21 *Hazards and Hazardous Materials* also addresses the volume and type of construction-related debris, particular hazardous wastes and the location of disposal.

Based on the anticipated volume of waste generation for the Proposed Project and the above identified capacities for local landfill facilities (described in Section 3.18.2.4 *Solid Waste*), there is sufficient permitted capacity to accommodate the solid waste disposal needs of the Proposed Project, in keeping with applicable statutes and regulations related to solid waste.

Significance

No significant impact

3.18.6 References

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3.19 Aesthetics

This section identifies and describes potential impacts to scenic resources of the Klamath River and adjacent landscape due to implementation of the Proposed Project.

Several comments were received during the NOP public scoping process relating to potential dam removal impacts on aesthetics, including the likelihood of adverse impacts due to the loss of scenic reservoir views. Several commenters felt that the reservoir footprints would be left as bare slopes with only mud and debris for an extended period of time prior to restoration, and that the loss of reservoir views after implementing the Proposed Project would adversely affect the viability of residential communities that currently surround Copco No. 1 and Iron Gate reservoirs. Individual public scoping comments are presented in Appendix A of this EIR.

3.19.1 Area of Analysis

Removal of the Lower Klamath Project could affect aspects of scenic quality throughout the Klamath River in California, including aspects like water clarity, fish viewing opportunities, and riparian and channel characteristics of the river downstream of the dams. However, potential aesthetic effects on these aspects would decrease with distance downstream from the Lower Klamath Project as the river is affected more by tributary inputs and less by the dams and associated facilities. Therefore, the primary Area of Analysis for aesthetics is within the viewshed of the Lower Klamath Project reservoirs, which includes the proposed Limits of Work in California (i.e., Copco No. 1, Copco No. 2, and Iron Gate dams, reservoirs, and associated facilities, and the areas identified as construction/demolition areas and staging areas) plus a buffer to the ridgeline surrounding the reservoirs. The secondary Area of Analysis for aesthetics includes those areas within view of the Klamath River downstream from Iron Gate Dam to the confluence with the Shasta River (RM 179.5), as well as the portion of the Klamath River extending upstream from Copco No. 1 Reservoir to the Oregon-California border, because these river reaches may be affected by removal of the upstream dams.

The Primary and Secondary Areas of Analysis were generated in Geographic Information Systems (GIS) to approximate the viewshed visible from the Limits of Work and reaches of the Klamath River from the Oregon-California state line to the confluence with the Shasta River, respectively. Where the Primary and Secondary Areas of Analysis overlapped (e.g., at the upstream end of Copco No. 1 Reservoir, see Figure 3.19-1), precedence was given to the Primary Area of Analysis. The viewshed was digitized to follow ridgelines of steep slopes visible using a 10-meter digital elevation model (DEM) hillshade and USGS topographic maps. The area visible from the ground was confirmed using the terrain and ground-level view tools in Google Earth©. The viewshed only includes land that is anticipated to be continuously visible from the Limits of Work or the Klamath River. For example, when ridgelines or peaks appeared to be visible in the distance, but the land between the Limits of Work or Klamath River did not appear to be visible, those areas were not included. The viewshed is meant to be all encompassing of views from anywhere within the Limits of Work, and viewshed limits are approximate and generalized. The Primary Area of Analysis was expanded into Oregon where the viewshed from the Limits of Work in California extended beyond the state line, but it was truncated at the state line along the Klamath River based on the assumption that an on-the-ground viewer would only be looking downstream toward California for the assessment of potential aesthetics impacts in California.

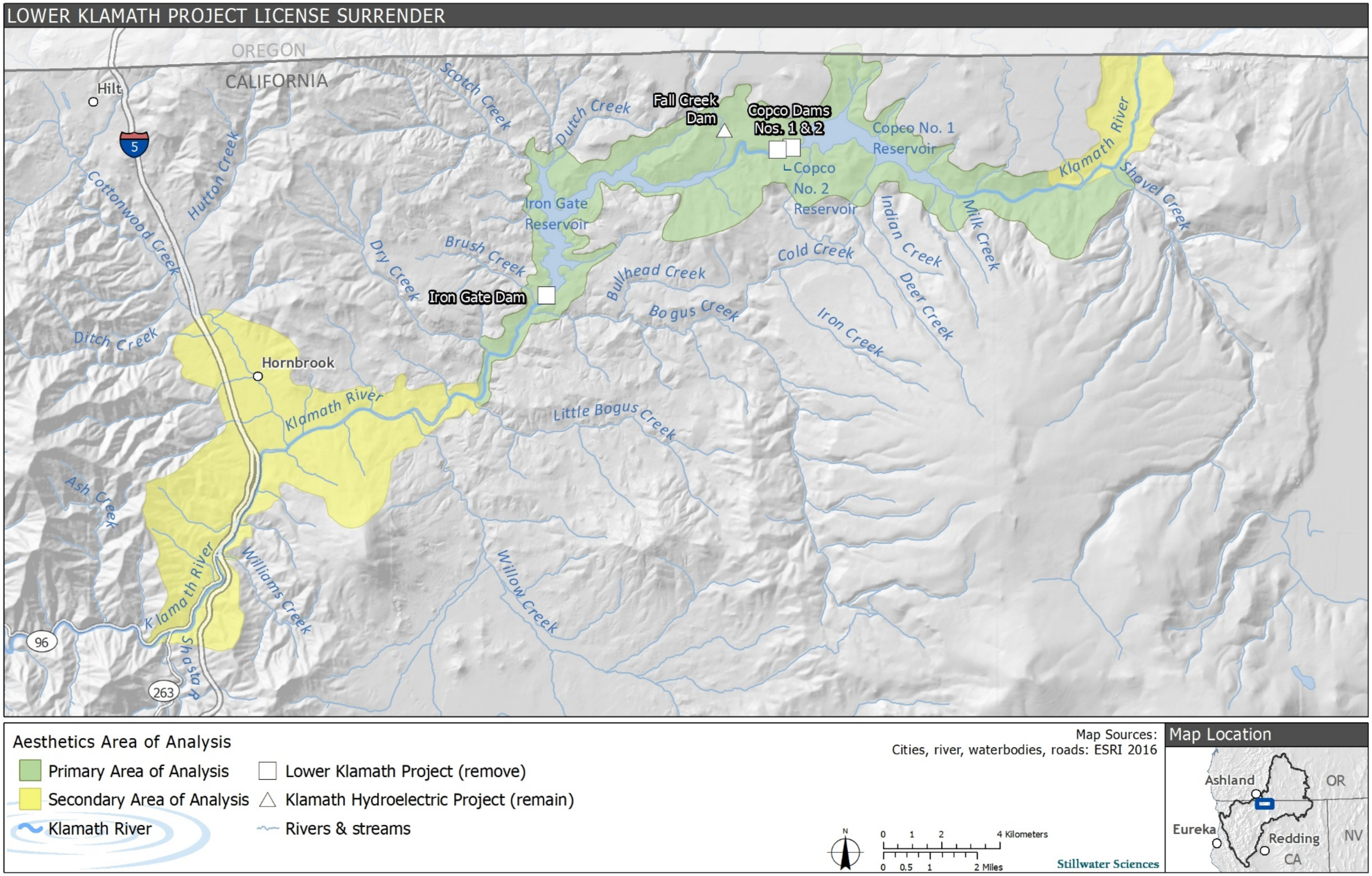

Figure 3.19-1. Aesthetics Area of Analysis.

3.19.2 Environmental Setting

The Klamath Basin as a whole contains widely varied scenic resources, including wetlands, uplands, rangelands, National Wildlife Refuges, farmlands, timberlands, and small urbanized areas in Yreka and along the Interstate 5 corridor. The Klamath Basin also supports vegetation communities including, but not limited to, montane hardwood and annual grasslands, as described in Section 3.5.2 *Environmental Setting*. Sightseeing opportunities to enjoy the scenic resources are widely available in the Klamath Basin generally, and more specifically within the Area of Analysis for aesthetics. Section 3.20 *Recreation* lists recreation resources, including Wild and Scenic River (WSR) segments, and locations in the surrounding region that offer wildlife viewing as well as opportunities for sightseeing, leisure drives, photography, and other forms of recreation.

This section provides further description of the environmental setting for scenic resources in the Area of Analysis pertinent to this and other resource impact analyses in this document.

3.19.2.1 PacifiCorp Analysis and Bureau of Land Management Methodology

PacifiCorp conducted a detailed visual evaluation of the project vicinity (FERC 2007) in 2002 and 2003 and documented it in the Land Use, Visual, and Aesthetic Resources Final Technical Report (PacifiCorp 2004a). This evaluation involved identifying and photographing key observation points during different seasons and documenting views of the reservoirs at different water levels. Photographs taken from these viewpoints portray typical scenic/landscape character along the Klamath River, including such features as canyon walls, channel configuration, water clarity, and bank and riparian appearance. Additional photographs were taken from selected locations in October 2010 (CDM 2010) and were compared to the 2003 photographs to verify the continued existence of earlier-documented conditions (Appendix R).

The following discussion describes the scenic resources found in the Area of Analysis for aesthetic resources. PacifiCorp (2004a) identified eight key observation points in the Hell's Corner Reach (Klamath River between J.C. Boyle Powerhouse and Copco No. 1 Reservoir), seven in the Copco No. 1 Reservoir area, twelve in the area of Iron Gate Reservoir, and three downstream of Iron Gate Dam.

These key observation points are not intended to be comprehensive but were selected to represent typical views (including scenic overlooks) for members of the public from riverside and/or reservoir communities and residences, recreational access sites, campgrounds, as well as scenic byways, and state highways 96, 169, and 101.

For their visual analysis, PacifiCorp used the Bureau of Land Management's (BLM) Visual Resource Management (VRM) process. Within their visual resource study area, PacifiCorp evaluated the way in which project features and operations fit into the overall visual landscape using the following three-step process: (1) identify the VRM classifications applicable within the study area; (2) define viewpoints from which Lower Klamath Project dams and associated facilities and operations could be seen; and (3) evaluate whether project facilities and operations, when seen from the viewpoints, conform to the objectives of the management classification in which they are found (PacifiCorp 2004a).

In response to the Federal Land Policy and Management Act (43 U.S.C. 35, §§ 1701 et seq.) and subsequent agency-specific regulations, federal land management agencies have developed systems specifically designed to inventory, evaluate and manage for scenic (visual) resources on public lands. As a result, the BLM developed the VRM system. The objective of BLM's VRM system is to manage public lands in a manner which will project the quality of the scenic (visual) values of those lands (BLM, 1984).

All BLM lands are assigned to one of four VRM classes, ranging from Class I, which includes the highest value scenery and associated protections, to Class IV, which reflects the lowest value scenery and associated protections. The VRM classes provide a valuation of existing visual resources and protection standards for determining Resource Management Plan conformance during project planning.

The Lower Klamath Project dams and associated facilities fall under the BLM Redding District Resource Management Plan. All of the facilities except three [all associated with J.C. Boyle] are located in areas that have been designated as a Class III area by an RMP or have been classified as a Class III area because the area has not been given a specific VRM class by BLM (PacifiCorp 2004). When evaluating project impacts, the objective for Class III visual resources is to "partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape" (BLM 1984).

For the purposes of this document, the site-specific, project level inventory is limited to the Area of Analysis and based upon a combination of original data from the 2004a PacifiCorp Technical Report and additional analysis from several key observation points. In addition to the aesthetic resources in the Area of Analysis being considered Class III, USBR and CDFW conducted a baseline Visual Resource Inventory within the Area of Analysis as part of the 2012 KHSA EIS/EIR, according to three components: scenic quality, visual sensitivity, and distance zones, as described below.

In terms of scenic quality, BLM's VRM methodology assigns public land a rating of A, B, or C (inherent scenic attractiveness), with A being the most distinctive and C being the most common, in terms of seven key factors including: color, water, vegetation, landform, influence of adjacent scenery, scarcity, and cultural modifications (BLM 1984). Based on review of the visual analysis completed for the 2012 EIS/EIR, all of the Proposed Project area would be contained within rating A landscapes due to the following key factors:

- **Color –** Some intensity or variety in colors and contrast of the soil, rock and vegetation, but not a dominant scenic element
- **Water –** Water flowing or still, dominant in the landscape when viewed from most KOPs, but not always clear and clean appearing
- **Vegetation –** A variety of vegetative types as expressed in interesting forms, textures, and patterns
- **Landform –** Steep canyons, some interesting erosional patterns or variety in size and shape of landforms; or detail features which are interesting though not dominant or exceptional

- **Influence of adjacent scenery –** Adjacent scenery moderately enhances overall visual quality
- **Scarcity –** Distinctive, though somewhat similar to others within the region
- **Cultural modifications –** Some modifications add favorably to visual variety while other add little or no visual variety or may be discordant

In terms of visual sensitivity, BLM's VRM methodology rates landscapes as either High, Moderate, or Low by analyzing the various indicators of public concern, including: type of users, amount of use, public interest, adjacent land uses, specially designated areas, and other factors. Based on review of the visual quality analysis completed for the 2012 EIS/EIR, all of the Area of Analysis would be considered High visual sensitivity because: (1) recreational sightseers are highly sensitive to changes in visual quality; (2) public interest and controversy in the area has increased in response to Proposed Project activities; (3) portions of the Area of Analysis are within the viewshed of residential areas; and (4) much of the Klamath River has been designated under the National Wild and Scenic Rivers Act (WSRA).

In terms of distance zones, BLM's VRM methodology classifies public lands as either foreground-middleground, background, or seldom seen. Based on review of the visual quality analysis, all of the Area of Analysis would be located with the foreground-middleground distance zone due to the proximity of views from recreational access sites along the river, campgrounds, key observation points along scenic highways, riverside and/or reservoir communities and residences, rivers, or other viewing locations, which are less than three to five miles away.

While all of the facilities have been classified as Class III as identified above, if BLM's Visual Resource Inventory Matrix (Table 3.19-1) is used the aesthetics Area of Analysis could be classified as VRM Class II, based on Class A distinctive scenic quality of high visual sensitivity as viewed from a foreground/middleground distance zone, from an inventory context. The objective of Class II is "to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape" (BLM 1984). If Class II objectives are applied, the changes due to the Proposed Project would be even more beneficial because they will return the areas to a more natural character, and would not change the significance of potential aesthetic impacts discussed in this section.

Table 3.19-1. Visual Resource Inventory Matrix.

Special Areas		Visual Sensitivity						
		High			**Medium**			**Low**
		I	**I**	**I**	**I**	**I**	**I**	**I**
Scenic Quality	**A**	II	II	II	II	II	II	II
	B	II	III	III* / IV*	III	IV	IV	IV
	C	III	IV	IV	IV	IV	IV	IV
		f/m	**b**	**s/s**	**f/m**	**B**	**s/s**	**s/s**
		Distance Zones						

Source: BLM 1984, KHSA 2012 EIS/EIR

Notes:

Highlighted cells indicate visual resource inventory determinations for the affected environment

* If adjacent area is Class III or lower assign Class III, if higher assign Class IV

Key:

b: background

f/m: foreground/middleground

s/s: seldom seen

3.19.2.2 Wild and Scenic Rivers and Scenic Highways/Byways

Klamath River components are part of the National (and state) Wild and Scenic Rivers System because of their free-flowing condition and "outstandingly remarkable" values. According to the WSRA (16 U.S.C. 1271 et. seq.) these outstandingly remarkable values include scenic, recreational, geologic, fish, wildlife historic, cultural or other similar characteristics. These values along designated wild and scenic reaches are protected by both the federal and state WSRA to various degrees, but all designated river segments must maintain at least a generally natural appearance along their waterways. The natural-appearing scenic quality within the more immediate and prominent portions of these rivers is also protected along these WSR segments by the WSRA.

The WSR segment of the Klamath River that could be affected by the Proposed Project include the mainstem of the Klamath River beginning 3,600 feet downstream from Iron Gate Dam and continuing 189 miles downstream to the Pacific Ocean. This WSR segment is recognized for its outstandingly remarkable fisheries. It is classified under the California WSRA as recreational (river segments that are readily accessible by road or railroad, and that may have some development along their shorelines, and may have been impounded or diverted in the past (PRC § 5093.53), with portions of the tributaries classified as scenic and wild.

Scenery within the California Klamath WSR is dominated by natural settings. Its water appearance, anadromous fish and riparian vegetation within a forested river canyon are the primary scenic aspects. Since its designation in 1981, flow regimes have varied moderately in response to water resource competition, government mandated flow requirements and weather within the Klamath Basin. During summer months, fluctuations in the flow regime have typically been caused by water diversions (Van de Water et al. 2006). As described in Section 3.20 *Recreation*, reduced water clarity and discoloration resulting from seasonal algae blooms has impaired the scenic character and recreational opportunities of the Middle and Lower Klamath River (see also Section 3.2 *Water Quality* and Section 3.4 *Phytoplankton and Periphyton*).

In addition, in 1990, BLM found the 5.3-mile section of the Klamath River from the Oregon-California state line to Copco No. 1 Reservoir eligible and suitable for WSR designation. The river segment is free-flowing and possesses outstandingly remarkable scenic, recreational, fish, and wildlife values. This river segment is not a designated WSR and is not protected under the National WSRA and its Section 7(a) requirements. However, agencies are still required within their authorities, to protect this suitable river segment's free-flowing character, water quality, and outstandingly remarkable river values. This segment of the Klamath River is also listed on the Nationwide Rivers Inventory to ensure protection of its river values (NPS 2009).

In addition, there are three Scenic Byways located along the Klamath River and within the Klamath and Six Rivers National Forests. The "State of Jefferson" National Forest Scenic Byway is located primarily on California State Highway 96 (Highway 96) between Shasta River to Happy Camp, and the "Bigfoot" National Forest Scenic Byway is located on Highway 96 from Happy Camp to California State Highway 299 (Highway 299). There is also an "All American Road" as classified by the U.S. Department of Transportation's Federal Highway Administration - the Volcanic Legacy Scenic Byway—which goes from Lassen National Park in California and through the Proposed Project area via Highways 97, 140, and 62 on its way to Crater Lake National Park in Oregon. These byways provide excellent views for sightseers within the Klamath and Six Rivers National Forests and access to numerous other recreational activities (America's National Scenic Byways 2010).

3.19.2.3 Klamath Watershed

Along the northernmost, eastern edge, upstream of the Area of Analysis, the Klamath River borders remnants of central Oregon's Modoc Plateau province. The river flows through a broad, flat valley that gradually transitions to a narrow channel as it crosses the low, rolling ridges of the Cascade Mountains.

The Upper Klamath Basin begins at the headwaters of the Klamath River in south-central Oregon and extends downstream into north-central California. This area includes agricultural lands and the Upper Klamath Basin National Wildlife Refuge Complex, which is comprised of six wildlife refuges and contains the USBR Klamath Irrigation Project. Regionally, a variety of public lands contain notable scenic resources. Table 3.20-1 in Section 3.20.2.1 *Regional Recreation* lists locations within the aesthetics Area of Analysis and surrounding region that offer opportunities for wildlife viewing, sightseeing, leisure driving, photography, and other forms of recreation that benefit from scenic quality.

In the central section of the Upper Klamath Basin, starting upstream of J.C. Boyle Dam, the topography changes dramatically, dropping rapidly into the 1,000-foot-deep upper Klamath River Canyon. The ruggedness of the terrain exemplifies the surrounding landscape, where nearby mountain peaks often reach 5,000 feet in elevation. As the Klamath River passes through the Cascade Mountains, the upper Klamath River Canyon represents a transition from the desert landscape in the east to a mountainous landscape in the west. The steep-walled canyon is the predominant visual element in the region. As it flows through the deep gorge, the river changes from slack, slow-flowing water in the broad, flat valley to a torrent of cascading whitewater. Less than five miles downstream of J.C. Boyle Dam, the canyon and neighboring ridges gradually become flatter and wider as the river flows southwesterly across the state line and into

Copco No. 1 Reservoir. Here, along the Proposed Project's western edge, the topography surrounding Copco No. 1 and Iron Gate reservoirs is open and rolling.

3.19.2.4 Klamath River Key Observation Points

Within the Area of Analysis, PacifiCorp identified eight key observation points in the Hell's Corner Reach (between J.C. Boyle Powerhouse and Copco No. 1 Reservoir), and four downstream from Iron Gate Dam (PacifiCorp 2004a). Many of the reaches have similar characteristics with the aesthetic differences between high flows and low flows varying depending on the individual physical features of each reach (e.g., during low flows, more rocks and vegetation were visible at the river edges than at high flows; in shallower areas, lower flows affected channel depth more greatly.

Figures 3.19-2 and 3.19-3 depict views of the Klamath River from two of the selected key observation points downstream of Iron Gate Dam. Under the range of flows observed, river water continues to inundate the entire channel width. Higher flows exhibit deeper water depth and higher flow velocity. Views of the Klamath River, downstream of the Lower Klamath Project dams and associated facilities, show a free-flowing river with broad channel dimensions. As a result, exposed shoreline margins and riverbed deposits are exposed under a wider range of flow conditions than the upstream sections.

Views of the Klamath River, upstream of the Lower Klamath Project dams and associated facilities (Figures 3.19-4 and 3.19-5), show a free-flowing river with similar surface area dimensions over a range of flows due to the narrower channel. Only the shoreline margins are exposed at lower flows of approximately 350 cfs. During higher flow conditions ranging up toward 2,800 cfs, water extends into adjacent upland vegetation.

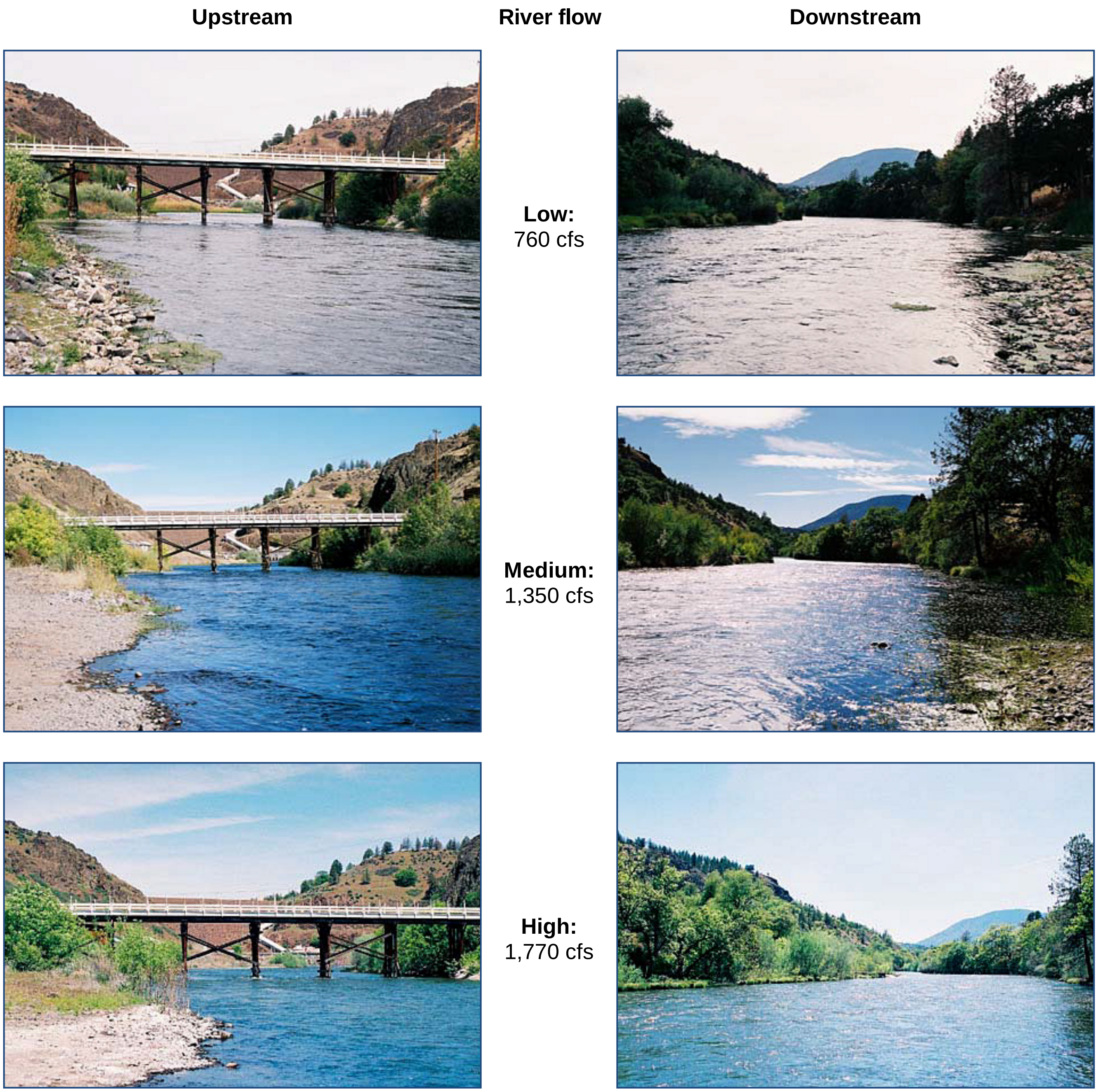

Figure 3.19-2. Views of Klamath River Downstream of Iron Gate Dam. Source: PacifiCorp 2004a.

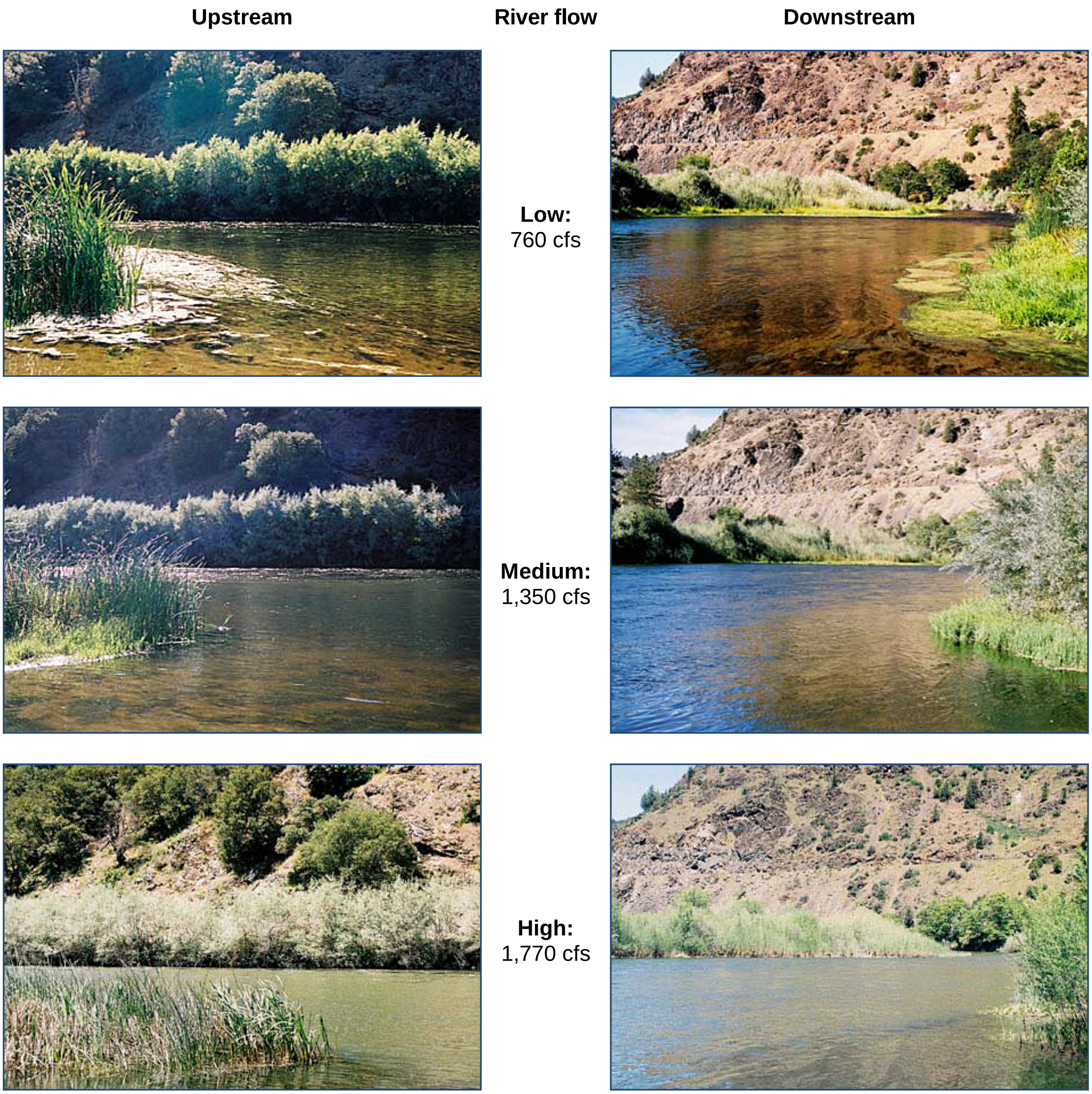

Figure 3.19-3. Views of Klamath River from Tree of Heaven River Access Boat Ramp (1.5 miles downstream of Iron Gate Dam). Source: PacifiCorp 2004a.

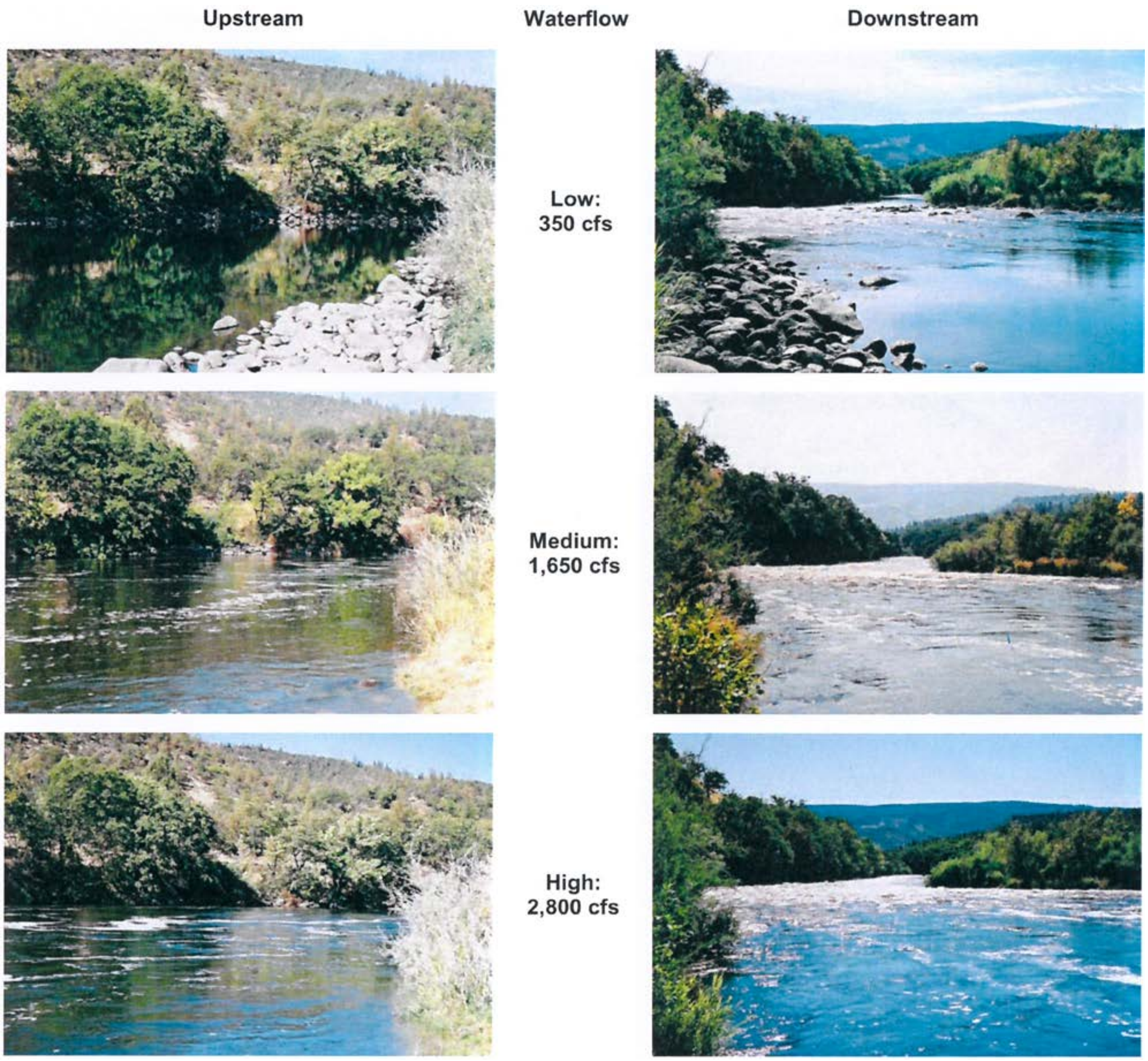

Figure 3.19-4. Views of Klamath River from Stateline Takeout. Source: PacifiCorp 2004a.

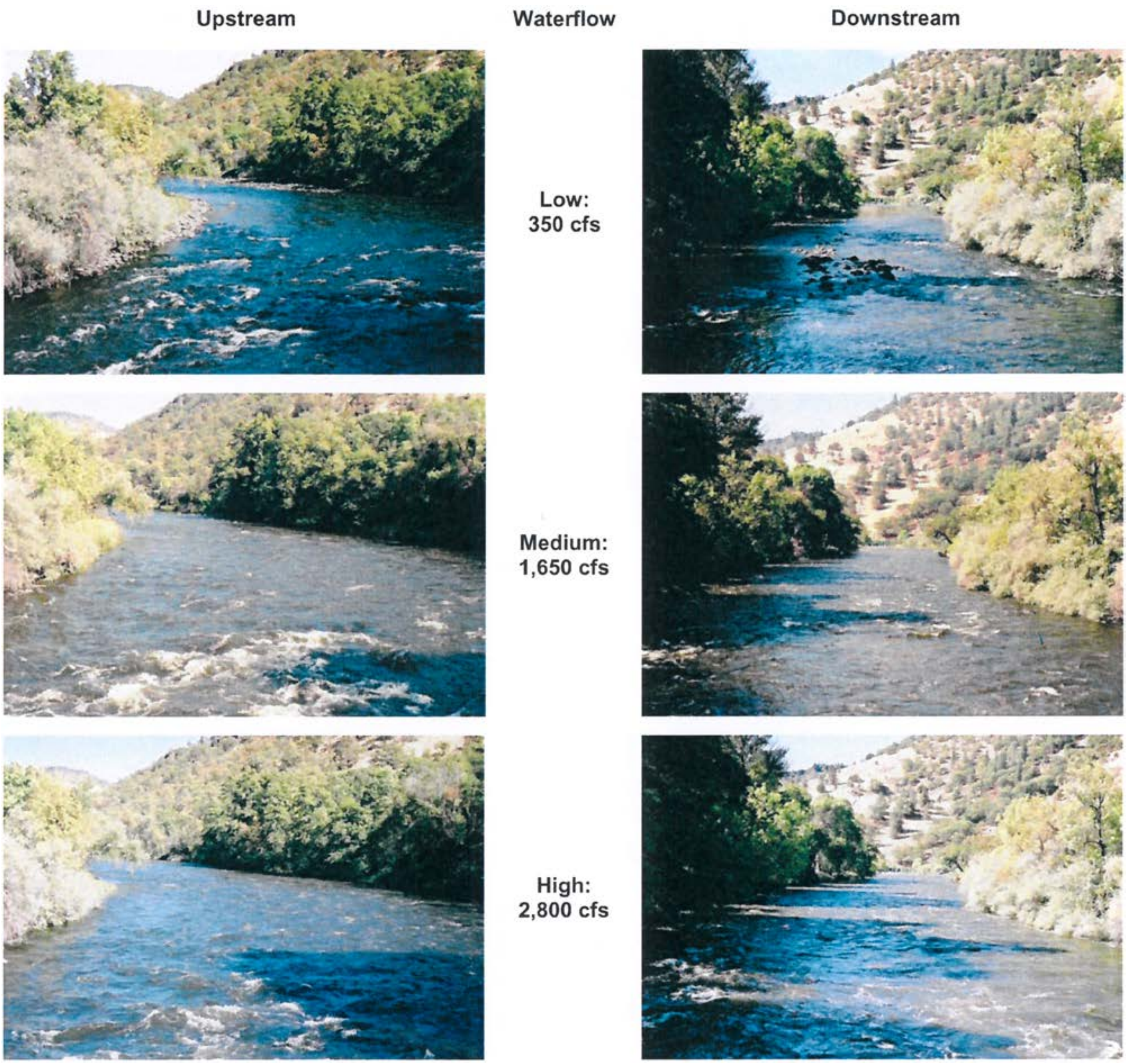

Figure 3.19-5. Views of Klamath River from Fishing Access #5 (Topsy Grade Road). Source: PacifiCorp 2004a.

3.19.2.5 PacifiCorp's Hydroelectric Project Facilities

Reservoirs

PacifiCorp (2004a) described the area landscape from nine key observation points in the vicinity of the reservoirs. All reservoirs were viewed under high pool and low pool conditions. In general, the reported visual observations of the reservoirs indicated that under normal operating conditions, the three reservoirs share the visual characteristics of open expanses of relatively flat water. Also, as described in sections 3.2 *Water Quality* and 3.4 *Phytoplankton and Periphyton*, seasonal algae blooms occur in the reservoirs, typically peaking in late summer to early fall. During particularly intense algal blooms, floating algae mats and scums often appear and concentrate in protected areas or along the shoreline where they are not exposed to wind.

Because the water surface elevations of these reservoirs do not fluctuate substantially, the visual appearance of the landscape does not change considerably over the course of the year. When the water surface is drawn down, limited shoreline material is exposed. However, this limited exposure does not detract from the view shown.

Residences along the Copco No. 1 Reservoir shoreline, of which there are approximately 140, have unobstructed views of the reservoir water surface. The waterbody dominates their views and likely enhances the aesthetic quality of this landscape. Views on Iron Gate Reservoir are similar, however, there are no permanent residences located along this reservoir's shoreline. Viewers are limited to recreationists utilizing the local roads and recreational facilities.

Lower Klamath Project Hydroelectric Facilities in California

PacifiCorp documented the scenic characteristics of the Lower Klamath Project facilities within the aesthetics Area of Analysis at the following seven key observation points (alphanumeric designations refer to key observation point designations and accompanying photographs in the PacifiCorp [2004a] report):

- C3: Copco No. 1 Dam and Powerhouse
- C4: Copco No. 2 Dam
- C6: Copco No. 2 Powerhouse
- C7: Copco Transmission Line
- IG8: Iron Gate Transmission Line
- IG9: Iron Gate Dam and Powerhouse from Iron Gate Fish Hatchery
- IG10: Iron Gate Fish Hatchery and Fish Ladder

In the PacifiCorp (2004a) report, the views of the three facilities from these key observation points were characterized using the BLM VRM system. The report describes each of the three facilities in the context of the BLM VRM classification for the surrounding area. It should be noted that these assessments were done using one single photo from quite close to each facility, which magnifies its influence on the visual landscape. These observations may be summarized by facility as follows:

- **Copco No. 1 Facilities**—Copco No. 1 Dam and Powerhouse were not considered to be consistent with the VRM Class III objectives of the surrounding area. The size and prominence of these facilities were considered to dominate the view from the key observation point. However, the Copco No. 1 transmission line was typically at a distance from the viewing points and would blend into the sky and not obstruct views of other parts of the landscape. Thus, the transmission line was considered to be consistent with VRM Class III objectives.
- **Copco No. 2 Facilities**—Copco No. 2 Powerhouse was not considered to be consistent with the VRM Class III objectives of the surrounding area because of its size and prominence the powerhouse dominates the view from the key observation point. However, although the Copco No. 2 Dam is large, it has been designed with colors and lines that blend with the landscape, and when viewed in isolation, or from a longer distance, could therefore be considered consistent with VRM Class III objectives.

- **Iron Gate Facilities**—The Iron Gate Dam, Powerhouse, and transmission lines were considered to be consistent with the VRM Class III objectives of the surrounding area in a detailed visual evaluation of the project vicinity as summarized in the Final EIS (2007) and documented in the *Land Use, Visual, and Aesthetic Resources Final Technical Report* (PacifiCorp 2004a). Although the dam and powerhouse are large, their colors and lines blend with the landscape. Similarly, the transmission line was typically at a distance from the viewing points and would blend into the sky and not obstruct views of other parts of the landscape. In instances where the support poles of the transmission lines were prominent, it was only for a short time while a viewer walks or drives by.

Figures 3.19-6 through 3.19-8 depict views of several project features located at Copco No. 1 and Iron Gate dams and associated facilities. The reservoir waterbodies are the dominant visual feature from both distant views and from shoreline locations.

Views of Copco No. 1 and Iron Gate dams are limited by topographic features that obstruct more distant views of these facilities. Views of Copco No. 1 Dam are limited to approximately 0.25 river miles downstream. Views are often blocked by local topography and the meandering course of the river. Views of Copco No. 2 Dam can also be limited because of local topography, the meandering course of the river, and vegetation. Copco No. 2 Dam can only be seen from a distance of approximately 500 feet due to these obstructions. Iron Gate Dam can be seen from a distance of approximately one mile at several residences located downstream of this facility. Views of the dam are partially obstructed by local topographic features.

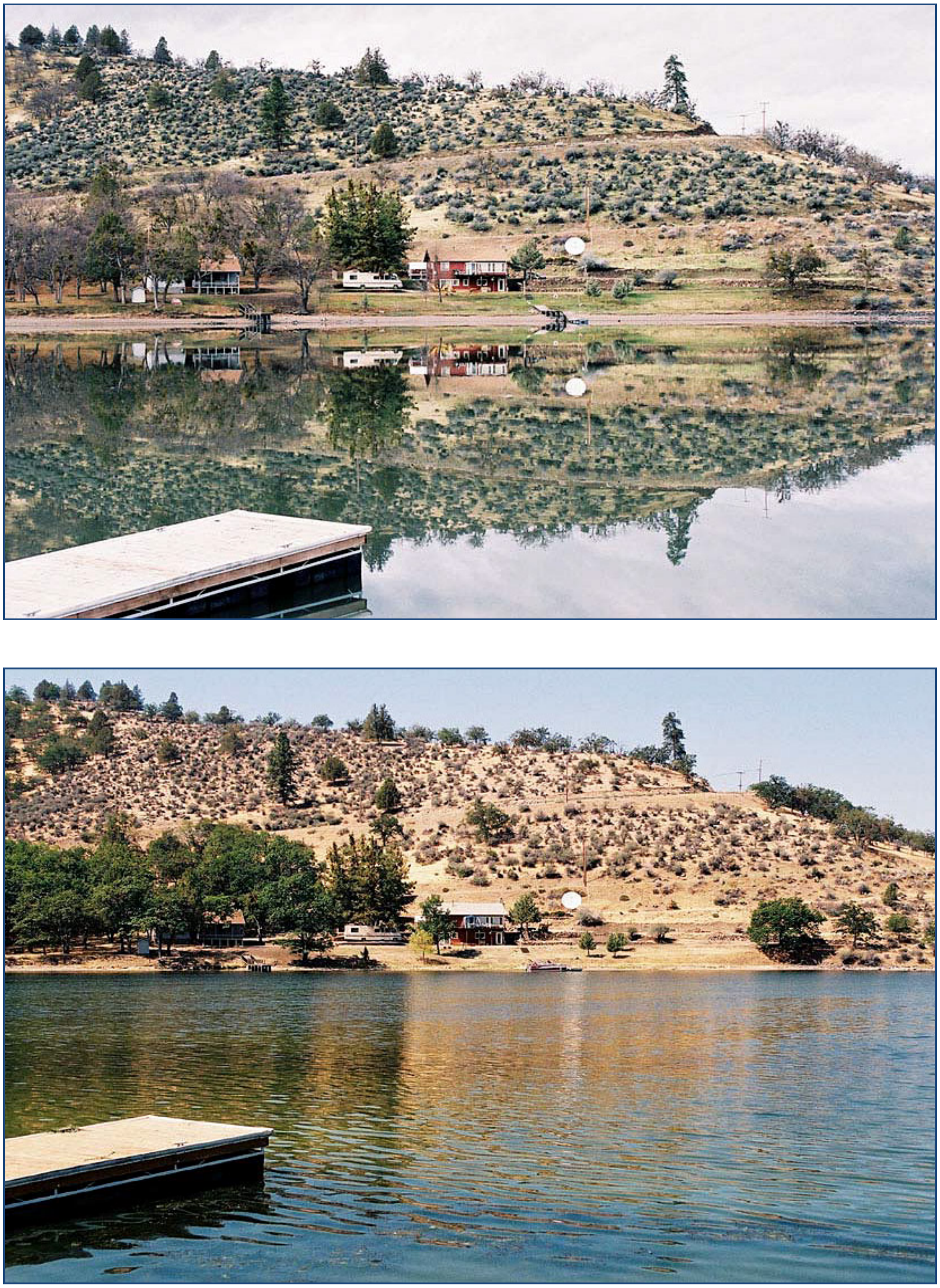

Figure 3.19-6. Copco Lake at Mallard Cove Recreation Area during Low and High Pool Conditions. Source: PacifiCorp 2004a.

Figure 3.19-7. Iron Gate Reservoir at Long Gulch Recreation Area during Low and High Pool Conditions. Note the algal mats in the second photo. Source: PacifiCorp 2004a.

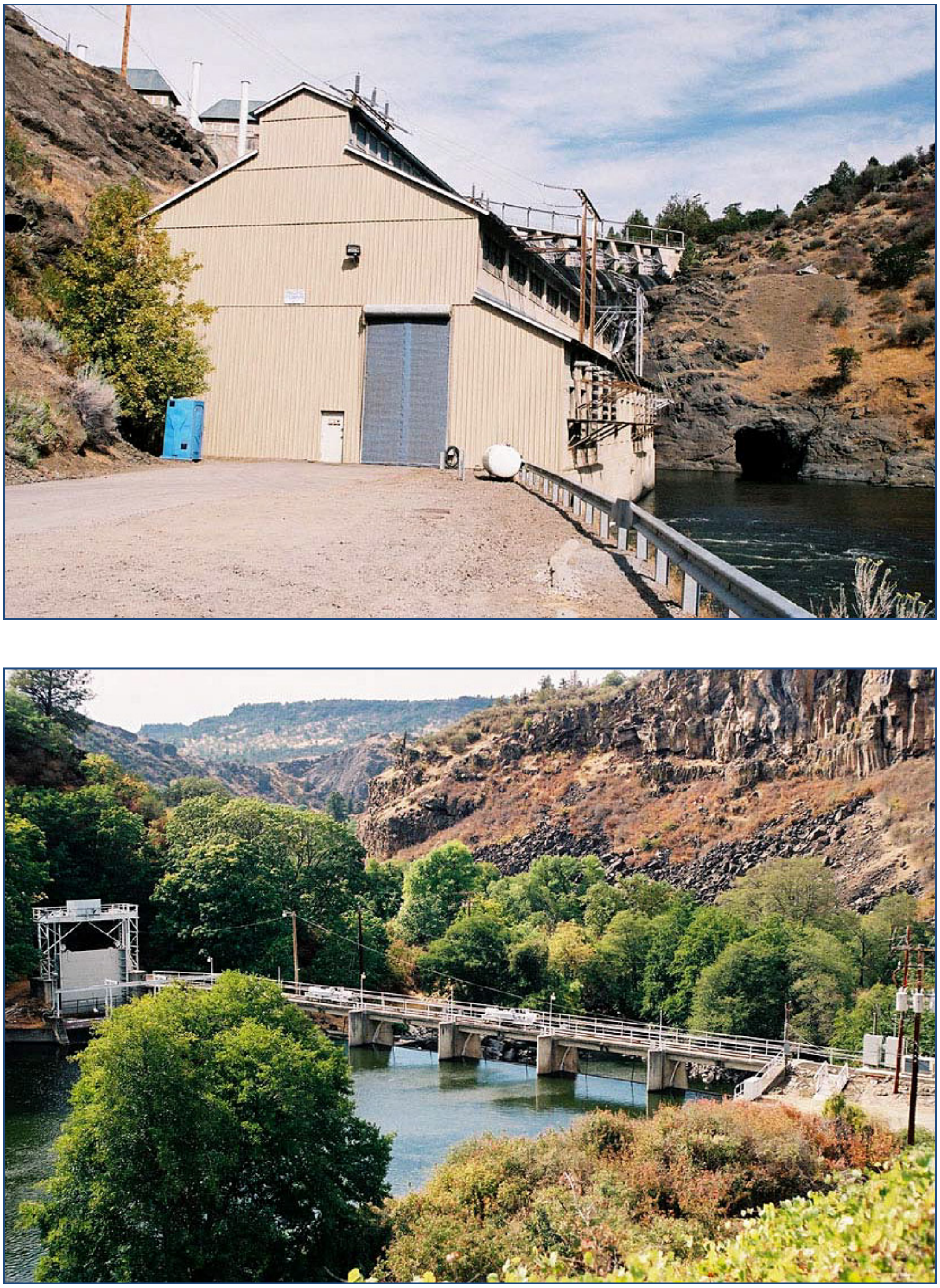

Figure 3.19-8. View of Copco No. 1 Powerhouse and Copco No. 2 Dam. Source: PacifiCorp 2004a.

3.19.3 Significance Criteria

Criteria for determining significant impacts on aesthetics are based upon Appendix G of the CEQA Guidelines (California Code of Regulations, title 14, section 15000 et seq.) and best professional judgement. Impacts are considered significant if the Proposed Project would:

- Cause a landscape to be inconsistent with the following Class III VRM objectives (BLM 1984): (1) the existing character of the landscape is partially retained; (2) the level of change to the characteristic landscape is moderate; (3) management activities may attract attention but would not dominate the view of the casual observer; and (4) changes would repeat the basic elements found in the predominant natural features of the characteristic landscape.
- Result in a loss of or substantial adverse change to scenic elements of a landscape (including, but not limited to, landforms, trees, and rock outcroppings) as viewed from a vista point, community, recreation site area, trail, scenic highway, or designated wild and scenic river reach.
- Substantially degrade the existing visual character or quality of the site and its surroundings.
- Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area.

3.19.4 Impact Analysis Approach

Aesthetic resources are generally not as amenable to simple quantification as other environmental resources considered under CEQA. Accordingly, the analysis of aesthetic resources in this EIR is primarily qualitative and acknowledges a degree of subjectivity, where one person's idea of what is aesthetically pleasing may not match another person's idea. However, certain guideposts or aesthetic goals can be used to guide an inquiry into what aesthetic changes many, or even most, viewers would find appealing or not. For these cases, the BLM's Visual Resource Management (VRM) methodology was used as guidance, since PacifiCorp previously had used this approach for a visual analysis of Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities (see also Section 3.19.2.1 *PacifiCorp Analysis and Bureau of Land Management Methodology*).

The Area of Analysis for aesthetics experiences four distinct seasons, within which Klamath River flows, reservoir water levels, and the appearance of vegetation vary. The detailed visual evaluation of the Project vicinity as summarized in the 2007 FERC EIS (FERC 2007) and documented in the *Land Use, Visual, and Aesthetic Resources Final Technical Report* (PacifiCorp 2004a) was used to characterize the Area of Analysis for aesthetics because the PacifiCorp (2004a) report included viewing the key observation points during different seasons and at different water levels over an extended time period. The PacifiCorp (2004a) report provides an assessment of a baseline measure of the scenic appeal of the aesthetics Area of Analysis through a Scenic Quality Evaluation consistent with the BLM inventory process. Scenic quality and sensitivity information were delineated and/or inventoried and documented spatially, in a manner that follows physical features in the landscape (PacifiCorp 2004a).

To evaluate the significance of potential impacts to scenic resources, the key observation points were reviewed to determine which scenic resources would be changed by the Proposed Project, with potential changes identified in terms of degree of contrast, relative size or scale, distance, visibility, and magnitude. Although the contrast rating forms provided in the BLM VRM process were not filled out for this EIR, the same basic steps were used to consider potential impacts of the Proposed Project. These steps include describing the characteristics of the existing landscape, as well as those of the Proposed Project, and assessing the contrast between the two. The scenic quality impact analysis for this EIR is built on the general premise that removal of human-made improvements and restoration of the area to more natural conditions (see Section 2.7.4 *Restoration Within the Reservoir Footprint*) would have overall beneficial effects on aesthetics for Class III visual resources, in light of the aesthetic resources significance criteria (see Section 3.19.3 *Significance Criteria*).

Changes in scenic quality were identified and evaluated by establishing a level of contrast (i.e., no effect [visual contrast is imperceptible], weak, moderate, and strong [contrast caused by the action would be substantial]) considering effects on form, line, color, texture, and comparing to approved VRM objectives for Class III areas. Light pollution effects that could be generated during construction were also considered.

Note that significance in visual contrast as defined under the BLM VRM system is not the same as a significance determination for the purposes of this EIR. The BLM VRM process and objectives are used as guidance for assessing the impacts of the Proposed Project, whereas the criteria used for significance determination for this EIR's impact analyses are guided by CEQA and professional judgement based on the significance criteria listed in Section 3.19.3 *Significance Criteria*.

This EIR analysis categorizes potential visual impacts associated with the project into five groups: (1) loss of open water vistas; (2) changes to the river channel, flows and water quality; (3) reservoir drawdown and restoration; (4) removal of the dams and associated facilities; and (5) construction impacts. Short-term construction-related impacts would occur during the deconstruction period, including reservoir drawdown and short-term restoration activities (zero to five years), while long-term impacts would include restoration activities beyond approximately five years following dam removal.

Because the Area of Analysis does not extend downstream of the confluence with the Shasta River (RM 179.5), the review of local plans and policies for aesthetics focuses on Siskiyou County. The following policies and objectives from the Siskiyou General Plan were reviewed and considered relevant to the Proposed Project: Conservation Element (1973) Objective F, and Scenic Highways Element (1975) Objectives 3 and 4. These objectives generally promote aesthetic characteristics of the land to benefit residents of the county and state, as well as tourists. The issues addressed by the aforementioned Siskiyou General Plan objectives, including revegetation of cut-and-fill slopes, are inherently addressed in the impact analyses presented in Section 3.19.5 *[Aesthetics] Potential Impacts and Mitigation*.

3.19.5 Potential Impacts and Mitigation

The Proposed Project involves removal of three dams in California (Copco No. 1, Copco No. 2, Iron Gate) and essentially all appurtenant features associated with the dams and related facilities, with the exception of buried features (Section 2.7 *Proposed Project*).

The Proposed Project includes reservoir drawdown prior to removal of the dams (Section 2.7 *Proposed Project*), which would expose the formerly inundated areas to view. The proposed reservoir restoration activities include revegetating the newly exposed reservoir areas with native species through hydroseeding and manual planting. Monitoring and adaptive management will be used to ensure affected areas are appropriately revegetated. Management of invasive exotic vegetation could include manual weed extraction, soil solarization (covering of ground areas with black visqueen), tilling, and use of herbicides (Section 2.7.4 *Restoration Within the Reservoir Footprint* and Appendix B: *Definite Plan*).

Under the Proposed Project, the hard lines of the dams and large expanses of water in the reservoirs would be changed to a more natural setting with river canyon landforms and vegetation framing a continuous river. Due to the surrounding mountainous topography, the dams themselves are not visible from more than one mile away. However, the long-term scenic change of removing the large expanses of water in the reservoirs would be visible for a very long distance around the prior reservoir locations and at most reservoir key observation points. Figures 2.7-5 and 2.7-6 show aerial photos of the existing reservoirs with an overlay of existing reservoir bathymetry, including the historical river channels. The historical river channels represent the projected long-term extent of the Klamath River following implementation of the Proposed Project. Immediately following reservoir drawdown, and until revegetation efforts are complete, areas within the reservoir footprints would appear barren and/or sparsely vegetated.

The existing water supply pipeline for the City of Yreka passes under the upstream end of Iron Gate Reservoir (Figure 2.7-17) and would be relocated prior to reservoir drawdown to prevent damage from increased water velocities and scour once the reservoir has been drawn down. Three options for modifying the pipeline are being explored. These include: (1) micro-tunneled crossing, (2) aerial crossing on a new utility bridge, and (3) aerial crossing on Daggett Road bridge (see also Section 2.7.7 *City of Yreka Water Supply Pipeline Relocation*). Also, several bridges within the aesthetics Area of Analysis would be replaced to address structural deficiencies and/or to raise them above the new 100-year flood elevation. The Proposed Project includes the complete removal of eight recreation sites (Table 2.7-14), including removal of structures, concrete, pavement, and most other existing recreation facilities, such as campgrounds and boat ramps that are currently located on the reservoir banks, and regrading and revegetating associated parking areas and trails (see also Section 2.7.8.3 *Recreation Facilities Management*). The removed recreation sites would be planted with a native seed mix as described in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*). Recreational facilities at Fall Creek and Jenny Creek Day-Use Areas at Iron Gate Reservoir, and the Iron Gate Fish Hatchery Day-Use Area, would remain and may be upgraded or enhanced (Table 2.7-15). Future enhancements at these locations would depend on the future ownership of Parcel B lands, where these three recreational facilities are located.

Aesthetic changes resulting from the aforementioned actions under the Proposed Project would occur in the short term (up to five years) and/or the long-term (more than five years). These aesthetic changes include the following:

- Long-term loss of open water vistas/views;
- Short-term and long-term changes in flows and channel morphology;

- Short-term and long-term changes in visual water quality, including increased turbidity and reduced algal blooms;
- Short-term bare/unvegetated area under former reservoirs after reservoir drawdown;
- Long-term visual changes due to removal of Lower Klamath Project dams and associated facilities, and improvements to or construction of new infrastructure (e.g., bridges, recreation facilities);
- Short-term visual impacts from stockpiles, lighting, and equipment.

Each of these potential aesthetic changes are analyzed below.

Potential Impact 3.19-1 Loss of Open Water Vistas.
The primary aesthetics Area of Analysis is rural. There are no major highways or towns within the viewshed of the reservoirs. However, there is a substantial amount of public land and public access to the area. While there is only one officially designated scenic overlook or vista point, recreational sites within the aesthetics Area of Analysis include the following:

- Nine developed recreation sites along the river corridor between the Oregon-California state line and Copco No. 1 Reservoir (all fishing access sites except for the “Stateline Take-out”);
- Two developed and two dispersed recreation sites at Copco No. 1 Reservoir;
- Eight developed and five dispersed recreation sites at Iron Gate Reservoir;
- Two developed recreation sites just downstream of Iron Gate Dam.

In 2001 and 2002, the California Lower Klamath Project reservoir recreation sites accounted for an average of 61,240 recreation days (defined as one visitor to a recreation area for any reason in a 24-hour period), and the river recreation sites accounted for an average of 12,500 recreation days, (PacifiCorp 2004), not including estimated angler days. In addition to the public land and recreational sites, there are also approximately 140 residences located around Copco No. 1 Reservoir, the majority of which are vacation homes. Also, several rural and local roads, mostly unpaved, provide access within and around the primary aesthetics Area of Analysis. Most of the nearby residents and the users of the recreational facilities associated with Iron Gate and Copco No. 1 reservoirs are there to enjoy activities on those reservoirs. Part of that experience includes the scenic, open water vistas of the area. (Potential impacts to recreational opportunities are discussed in further detail in Section 3.20 *Recreation*)

Sightseeing is a popular activity within the aesthetics primary Area of Analysis, with 39 percent of all respondents to a recreational survey of the area participating in that activity (PacifiCorp 2004b). However, sightseeing was less popular around the Lower Klamath Project dams and associated facilities, with only 30 percent and 32 percent of visitors participating in that activity at Copco No. 1 Reservoir and Iron Gate Reservoir, respectively (PacifiCorp 2004b). Conversely, 46 percent of respondents participated in sightseeing within the Hell's Corner River reach, between Copco No. 1 and J.C. Boyle reservoirs (which is in the secondary Area of Analysis and partly in Oregon), indicating that the river itself provides a more important visual resource for visitors than the reservoirs. Boat fishing, camping and resting/relaxing were the three most popular activities at both Copco No. 1 and Iron Gate reservoirs (PacifiCorp 2004b).

Long-term scenic vistas within the primary Area of Analysis would not necessarily be lost as a result of the Proposed Project, but they would be altered. Open water and lake vistas would be lost in favor of more natural river, canyon, and valley vistas. While not all people prefer a more natural, riverine setting, the results of prior surveys (PacifiCorp 2004b) suggest that in general the free-flowing river is preferred to the flatwater reservoir views. For those recreationalists that prefer lake and open water scenes, there are numerous other lakes and reservoirs in the region. In Siskiyou County there is vehicular access to more than 30 boatable lakes. There are another 56 boatable lakes in Jackson and Klamath counties to the north in Oregon (PacifiCorp 2004b). The recreation facilities within the aesthetics Area of Analysis were the primary destination of 54 percent of the recreation survey respondents (PacifiCorp 2004b), indicating that many users are just passing through and/or are visiting other destinations as well, reducing the severity of the impact of the loss of the Lower Klamath Project reservoirs.

Some of the owners of the residences located around Copco No. 1 Reservoir have expressed concerns about the loss of lake views from their property. Presumably those homeowners, whether permanent residents or sporadic users, chose to purchase or build those residences based on proximity to the reservoir. Because of the public access and recreational facilities, the Proposed Project would affect the environment of persons in general, not just individual property owners.

While the change from nearby flatwater reservoir views to further-away riverine views would presumably be considered a negative change for the owners and users of residences located around Copco No. 1 Reservoir, based on available survey results the change would not substantially degrade the existing visual quality of the primary Area of Analysis for the viewing public as a whole. Furthermore, although the reservoirs could be considered scenic resources in their own right, they are in general not consistent with the Class III VRM designation, because their creation changed the character of the natural landscape and they dominate the view from many public view locations. In addition, the Copco No. 1 and Iron Gate reservoirs often appear in a visually degraded condition due to summer algal blooms, which negatively impact a majority of recreational survey respondents (see Potential Impact 3.19-3). Once the river is restored, open water vistas would be replaced by a different, more natural setting and associated vistas, consistent with the VRM classification. Therefore, the long-term change from open water lake vistas to river, canyon, and valley vistas within the primary Area of Analysis would be less than significant.

Significance
No significant impact

Potential Impact 3.19-2 Changes in Flows and Channel Morphology.
The aesthetics primary Area of Analysis (i.e., within the viewshed of the Lower Klamath Project reservoirs, which includes the proposed Limits of Work in California, see Figure 3.19-1), is not visible from any of the nearby designated scenic byways, highways, or the WSR sections of the river. However, the Proposed Project could affect flows and channel morphology within the WSR sections that are associated with the aesthetics secondary Area of Analysis, which could affect scenic elements of the landscape as viewed from a vista point, community, recreation site area, trail, scenic highway, or river vantage point within the designated WSR sections.

Within the aesthetics secondary Area of Analysis, the stretch of the Klamath River from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir has been determined to be eligible for listing under the WSRA. In addition, the mainstem Klamath River from 3,600 feet below Iron Gate Dam downstream to the Klamath River Estuary has been designated as "Recreational" under the WSRA. There are a number of fishing access sites along the Klamath River from the California-Oregon state line to the upstream end of Copco No. 1 Reservoir, as well as downstream of Iron Gate Dam. The river is also visible from several roadways that run along the channel within the Area of Analysis.

Although the portion of the Hydroelectric Reach between Copco No. 1 Reservoir and the Oregon-California state line would not be impacted by any of the decommissioning or restoration activities occurring in California, flow characteristics within this reach (which is within the aesthetics secondary Area of Analysis) would be impacted by the removal of the J.C. Boyle Dam approximately 15 river miles upstream. Similarly, flow characteristics and channel morphology would change in the WSR segment downstream of Iron Gate Dam to the confluence with the Shasta River (RM 179.5).

Potential changes to flow characteristics include the timing, duration and magnitude of flows. These changes can impact the physical structure (morphology) of the river channel and the riparian vegetation. Much of the channel morphology within the secondary aesthetics Area of Analysis closest to the hydroelectric facilities is bedrock-controlled, which means flows do not have a significant influence on the channel configuration (Philip Williams & Associates, Ltd. [PWA] 2009), though there may be some minor changes to small alluvial floodplains. Comparing the annual hydrographs[168] from USGS stream gages on the Klamath River upstream and downstream of the Lower Klamath Project, similar patterns can be seen across years (USBR 2011). The primary flow-related effects of the Lower Klamath Project dams are: (1) dams create unnatural “steps” in the hydrograph due to controlled releases during the dry season, (2) dams generate somewhat higher flows in the late summer and lower flows in the late fall than what would occur naturally, and (3) dams allow attenuation of large storm events during the wet season. Though storm flows are somewhat attenuated by the dams, the impacts of that attenuation is lessened by non-attenuated tributary inputs; the hydrograph effects can still be discerned at the Seiad Gage (approximately RM 132.7) but are barely discernable at the Orleans Gage (approximately RM 58.9) (USBR 2011). Note that these hydrograph patterns would not be readily noticeable to the casual observer along the Klamath River and since they are outside of the aesthetics secondary Area of Analysis, they are not discussed further.

Overall, hydrologic modeling (see Section 3.6 *Flood Hydrology*) indicates that the flows in the Klamath River would not be expected to be substantially different from current conditions downstream of the confluence with the Shasta River (RM 179.5) due to tributary inputs. Water flow is expected to remain visually similar to current flow levels, and the existing river channel configuration patterns would likely be continued. Some aggradation of the channel immediately downstream of the dams is expected with the return of a natural sediment load. However, this would represent a return to natural

[168] A hydrograph is a graph depicting the rate of flow (discharge) versus time past a specific point in a river, channel, or conduit carrying flow. An annual hydrograph depicts rate of flow (discharge) over a 365-day period and often uses a water year designation (i.e., October 1 to September 30).

conditions and is considered desirable. The changes to flow characteristics within the secondary aesthetics Area of Analysis resulting from the Proposed Project would not result in a loss of or substantial adverse change to scenic elements of the landscape (including, but not limited to, landforms, trees, and rock outcroppings) as viewed from a vista point, community, recreation site area, trail, scenic highway, or designated WSR as compared with current conditions, and therefore, there would be no impact. See Section 3.6 *Flood Hydrology* for a discussion of potential impacts due to flood hydrology.

Significance
No significant impact

Potential Impact 3.19-3 Changes in Visual Water Quality.
There would be visible changes in downstream water quality resulting from the Proposed Project, including short-term increases in turbidity in the Hydroelectric Reach, Middle and Lower Klamath River, and Klamath River Estuary during reservoir drawdown, as well as long-term decreases in summer algal blooms after dam removal.

Short-term Changes in Visual Water Quality
Due to their general lack of cohesion, the majority of the accumulated sediment deposits currently in the reservoirs would be eroded during reservoir drawdown (Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*). The erosion of reservoir sediment deposits would result in short-term increases in turbidity and reduced clarity within and downstream of the Lower Klamath Project for several weeks to months during the reservoir drawdown period. Sediment jetting would be used at selected locations within Copco No. 1 and Iron Gate reservoirs to maximize erosion of accumulated sediments during drawdown. Revegetation efforts would occur immediately following drawdown, minimizing the potential for prolonged increases in turbidity due to erosion of sediment deposits remaining in the reservoir footprints (Section 2.7.4 *Restoration Within the Reservoir Footprint*).

Suspended sediment concentrations (and turbidity) are expected to return to background concentrations by the end of summer during dam removal year 1, with most of the erosion occurring by March 15, regardless of the water year type. The amount of the remaining sediment deposits in the active channel after drawdown would vary based on the hydrologic conditions, with a wet year eroding more than a dry year and the KRRC's proposal for sediment jetting increasing the potential that sediments on the two-year floodplain would be eroded to the extent possible (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*). The short-term pulse of sediment could also cause some deposition in eddies and slack water pools until subsequent annual flood events move the sediment to the ocean. Depending on the severity of the color change and volume of the deposits, this could represent a weak to moderate contrast from the existing conditions, as further described in the paragraph below. Impacts would decrease the farther downstream the viewing point is from the dams.

The primary drawdown period for the J.C. Boyle Dam, which is upstream of the aesthetics Area of Analysis, would occur between January 1 and January 31 of the drawdown year. Drawdown of Copco No. 1 Reservoir would likely commence on November 1 of the year prior to drawdown, but no significant sediment release is expected until after January 1. Drawdown would be completed by March 15 of the drawdown year. Drawdown of Iron Gate Reservoir would also start January 1, with water levels controlled through the spring (Section 2.7 *Proposed Project*). Copco No. 2

Dam does not impound a significant volume of sediment, and drawdown of this reservoir would occur after Copco No. 1 Reservoir is drained to grade. Due to naturally high levels of turbidity in the river during winter flows, increased turbidity from the Proposed Project would not be noticeable for most of the drawdown period. In addition, impacts would occur for a period of less than six months. Therefore, visual impacts from increased turbidity and reduced clarity related to sediment discharges would be less than significant.

Long-term Changes in Visual Water Quality
Existing summer algal blooms in the Lower Klamath Project reservoirs adversely impact water quality, salmonids, recreation, and aesthetics (Section 3.2 *Water Quality*, Section 3.3 *Aquatic Resources*, Section 3.4 *Phytoplankton and Periphyton*). More than 66 percent of recreational survey respondents indicated that water quality detracted from their experience at least a little at both Copco No. 1 and Iron Gate reservoirs; 91 percent indicated the same concern about the Hell's Corner Reach. Algae was the primary water quality concern cited by respondents (PacifiCorp 2004b). The Proposed Project would reduce the occurrence and severity of algal blooms (Potential Impact 3.4-2). The removal of the dams is expected to reduce the river's summer algae concentrations, which result in changes to both water clarity and coloration. Improvements in water quality, such as water clarity or fish viewing opportunities, could result in some improvement in scenic resources. These improvements would be more noticeable from on-river and riverside viewpoints, and much less noticeable from river canyon roadway and community viewpoints. These improvements to water quality would be beneficial.

Significance
No significant impact from short-term changes in water quality including increased turbidity and reduced clarity

Beneficial due to long-term changes in visual water quality from reduced algal blooms

Potential Impact 3.19-4 Visual changes resulting from reservoir drawdown and restoration including temporarily bare/unvegetated banks.
Substantial areas of bare sediment and rock would be exposed in previously inundated areas after reservoir drawdown and dam removal. Much of these areas would remain relatively bare, consisting mostly of grass and small forbs, during the summer and first wet season after dam removal, while larger vegetation becomes reestablished. Because much of the sediment would be eroded during reservoir drawdown, and because the river is bedrock-controlled, the river channel would not appear to be to significantly entrenched or flowing through mud, but rather, is expected to appear very similar to conditions before the river was impounded, though lacking in vegetation. Some slumping of the remaining sediment is anticipated, followed by drying, cracking, and hardening of the sediment prior to the establishment of vegetation. Existing wetland vegetation on the reservoir shorelines may also die off, though some of it would be relocated to repopulate the newly formed and exposed banks (Appendix B: *Definite Plan – Appendix H*).

As proposed in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*), manual revegetation would occur quickly following reservoir drawdown while the sediment deposits are still wet. In the short term, all exposed areas would be hydroseeded. Woody vegetation would also be planted in the year immediately following drawdown. Planting areas would be divided into zones (e.g., upland, riparian) that would have different species composition. Based on monitoring results, reseeding and replanting would occur again, as needed, for the following five years. Monitoring, revegetation, and invasive species control would occur annually until vegetation is reestablished and reservoir management goals are met (Appendix B: *Definite Plan – Appendix H*).

Until the restoration is complete, some areas could appear barren and/or sparsely vegetated. In addition, some tree-dominated wet areas that are currently near the reservoir edges may experience die-offs, but these areas account for less than 10 percent of the shoreline areas (see Potential Impact 3.5-22 and Figures 3.5-4 and 3.5-5). Revegetation of herbaceous species in barren and/or sparsely vegetated areas is anticipated to be achieved in the short term (from less than one to three years). However, it should be noted that this is not necessarily consistent with restoration of natural-appearing vegetation patterns below and above the reservoir line. Natural-appearing mature vegetation patterns with woody riparian vegetation may require 10 to over 50 years to develop. Although the condition is considered temporary, some adverse scenery impacts would be extensive and long-term, perhaps requiring 30 years for the river corridor habitats to fully recover from dam removal (PWA 2009). However, much of the aesthetics primary Area of Analysis is grassland, which would revegetate rapidly (from less than one to three years). Woody vegetation would begin to grow and add variability to the landscape within a few years, decreasing the contrast with undisturbed areas over time.

Based upon the proposed Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*), the aesthetics primary Area of Analysis would be in a visible state of transition for four to five years, followed by several more years where contrast from adjacent natural woodlands, where they exist, would be evident. The exposure of previously inundated areas would be considered a moderate contrast from the existing condition under the VRM rating system, because it would attract attention and dominate the landscape encompassing a large area surrounding the river. It would likely be visible from various key observation points around each of the existing reservoirs. However, much of the vegetation around the reservoirs is grassland, which would have less contrast with the restoration areas. In addition, a moderate contrast is still consistent with the Class III objectives. It is expected that within five years, the contrast would be moderate or less.

Therefore, while aesthetic impacts due to barren areas within the reservoir footprints would be significant and unavoidable in the short term until vegetation in previously inundated areas has established, the long-term visible contrast from adjacent natural woodlands, where they exist, would be less than significant.

Significance

Significant and unavoidable in the short term due to reservoir drawdown

No significant impact in the long term due to reservoir drawdown

Potential Impact 3.19-5 Visual changes resulting from the removal of Lower Klamath Project dams and associated facilities and improvements to or construction of new infrastructure.

Demolition Impacts

Under existing conditions, many of the Lower Klamath Project facilities do not blend with the natural landscape and can dominate views due to their form, line, color, size, or locations, particularly those that appear taller from a distance than other natural features. Because, the Lower Klamath Project facilities are inconsistent with the VRM classification for the surrounding area, their removal would result in a landscape that would appear more similar to the surrounding characteristic natural landscape. Figures 3.19-9 and 3.19-11 show photo-simulations of the removal of Iron Gate Dam and Copco No. 1 Dam, respectively. As discussed above, the dams themselves are generally not visible for any scenic highway and the topography of the area makes the dams themselves generally not visible from most vantage points. Accordingly, any dam-related landscape disturbances that are not fully restored to natural conditions by revegetation do not have the potential to cause significant impacts. The aesthetic impacts of removing the Lower Klamath Project dam complexes would be beneficial.

Some of the Lower Klamath Project facilities are considered to be historic structures (FERC 2007), including the Copco No. 1 Powerhouse and Dam; Copco No. 2 Powerhouse; and, the Copco No. 2 wooden stave penstock (see also Table 4.3-1, Table 4.3-3, and Table 4.3-5). However, these particular structures are not visible from any scenic highways or river sections. Potential impacts to historic resources are discussed in more detail in Section 3.12.5 *[Historical Resources and Tribal Cultural Resources] Potential Impacts and Mitigation Measures* but, for purposes of potential impacts to aesthetics, removal of these structures will have no impact.

Improvements/New Recreation Facilities

The Proposed Project includes replacement of the 24-inch diameter water supply pipeline for the City of Yreka, which crosses under the Klamath River near the upstream end of Iron Gate Reservoir. There are a number of residential, commercial, and industrial developments in the vicinity of the City of Yreka water supply pipeline (see Section 2.7.7 *City of Yreka Water Supply Pipeline Relocation*). In addition, Daggett Road Bridge is located approximately 2,000 feet upstream of the current pipeline. Due to the other development nearby, a new bridge or aerial pipeline would be seen as a new feature but would not conflict with or degrade the existing visual quality or character of the site or its surroundings. The aesthetic impact would be less than significant.

In addition, at least six bridges would need to be replaced due to structural deficiencies and/or in order to raise them above the new 100-year flood elevation. There are also culverts and roads that would need to be upgraded with new erosion and drainage control improvements (Appendix B: *Definite Plan*). However, these improvements would result in only minor visual changes to existing structures. New bridges would be built in the same general location as the ones being removed and would be sized and oriented similarly. Associated construction activities would be small-scale and temporary, consistent with normal road and infrastructure maintenance activities. Therefore, they would not degrade the existing visual character of the sites or their surroundings and the impact is less than significant.

The Proposed Project also includes removal of eight recreational facilities on Copco No. 1 and Iron Gate reservoirs and modification of three other facilities. In addition, KRRC has developed a Draft Recreation Plan (Appendix B: *Definite Plan – Appendix Q*) that seeks to identify recreation opportunities, in coordination with stakeholders, that would offset the removal of reservoir recreation opportunities and the reduction in whitewater boating days associated with the Proposed Project. New river-based opportunities may include: (a) new routes and roads for river access; (b) two small to medium river recreation facilities that would accommodate 20 campsites, day use amenities, and access to the river for fishing and boating; and (c) a new trail between J.C. Boyle Dam and the Iron Gate Fish Hatchery (see also Section 2.7.8.3 *Recreation Facilities Management*).

The areas in which recreation facilities that currently exist but are proposed to be removed are located will be restored through regrading and revegetating those areas, which would minimize aesthetic impacts. Construction of new facilities could have long-term aesthetic impacts depending on the final design and location of the new facilities. New recreation facilities are anticipated to be modest in size and spread throughout the Primary Area of Analysis. Therefore, they would have minimal potential to be inconsistent with the aforementioned aesthetics significance criteria. In addition, a Draft Recreation Plan will be developed by KRRC working with appropriate agencies through the FERC process, and KRRC also proposes that KRRC and the appropriate state and local agencies work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference to licensees to be 'good citizens' of the communities in which the project area is located and thus to comply, where possible, with state and local requirements. With these expected processes and opportunities for public and/or agency input, it is unlikely that new recreation facilities will be constructed that are inconsistent with the aesthetics significance criteria; however, overseeing development and implementation of terms and conditions relating to aesthetics of new recreation facilities does not fall within the scope of the State Water Board's water quality certification authority. Because the State Water Board cannot ensure implementation of measures in the Final Restoration Plan that would minimize potential aesthetic impacts, the visual impacts of new recreation facilities is considered in this Draft EIR as significant and unavoidable.

Significance

No impact in the long term due to removal of the Lower Klamath Project dams and associated facilities

No significant impact in the long term due to improvements to and construction of new infrastructure

Significant and unavoidable in the long term for new recreation facilities

Figure 3.19-9. Iron Gate Dam Before Removal (top) and a Simulation of What the Facility Could Look Like After Dam Removal (bottom) Except for Landform/Vegetation Restoration Details Which Were Not Known at the Time of Simulation. Note that the residence shown in the foreground would also be removed under the Proposed Project Source: 2012 KHSA EIS/EIR.

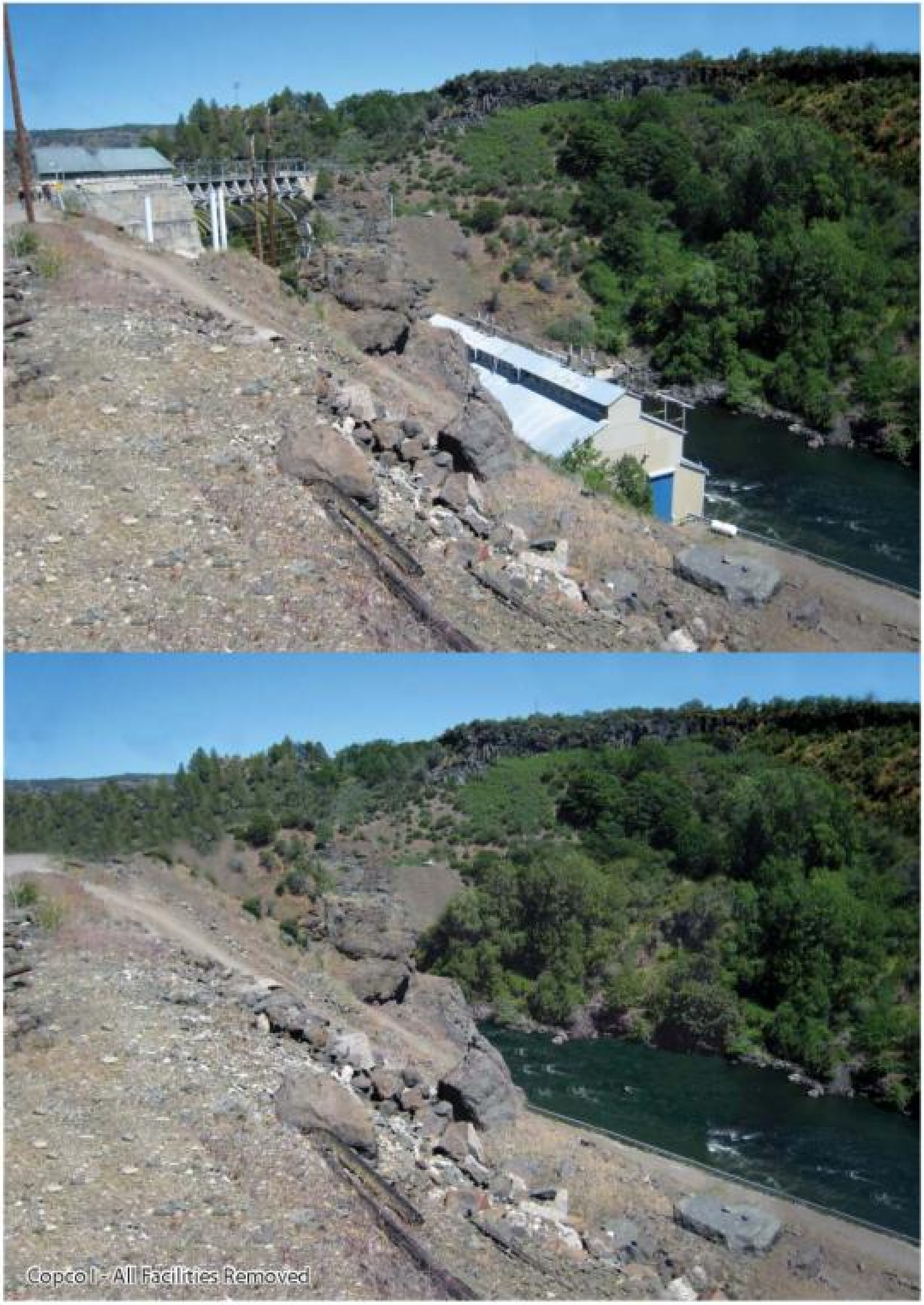

Figure 3.19-10. Copco No. 1 Dam Before Removal (top) and a Simulation of what the Facility Could Look Like After Full Removal (bottom) Except for Landform/Vegetation Restoration Details Were Not Known at the Time of Simulation. Source: 2012 KHSA EIS/EIR.

Potential Impact 3.19-6 Short-term visual impacts of construction activities/equipment.

Removal of the Lower Klamath Project dams and associated facilities would be completed in stages over one year, with primary deconstruction activities occurring between May and September (Table 2.7-1). During the deconstruction, the aesthetics primary Area of Analysis would have large construction vehicles and equipment, temporary structures (e.g., trailers, portable toilets, security fencing, temporary power supply, fueling stations), temporary access roads, equipment storage areas, material stockpiles, piles of demolition materials (rock, concrete, steel), and other common construction items that would detract from the natural surroundings. Proposed construction activities are anticipated to range from weak (the element can be seen but does not attract attention) to strong (the element demands attention, would not be overlooked and dominates the landscape) contrasts, depending on the amount of vehicles, equipment, and materials in any given area. During ongoing construction activities, portions of the primary Area of Analysis near those activities would be inconsistent with the applicable VRM classification. Some scenic resources, such as trees, rocks, and vegetation in the immediate vicinity of the dams would need to be removed but areas will in general be restored to a natural appearance, including through revegetation.

During construction some material stockpiling areas may be visible but may not stand out because the color and form of the materials may blend in to the surrounding landscape. However, in most instances temporary stockpiling of dam fill materials, along with larger vehicles and construction equipment, would cause a moderate to strong contrast as the color and form are anticipated to stand out substantially from the existing landscape. Stockpile areas and most equipment will not be readily visible from most key observation points. In addition, after construction, all vehicles, equipment, and stockpiles would be removed and the area would be restored to relatively natural conditions (regraded, covered with topsoil and hydroseeded). There will be no long-term visual impacts from construction activities.

Dust emissions from dam removal activities may also temporarily impact views and enjoyment of the river. The majority of fugitive dust generally settles out of the atmosphere within 300 feet of the source, with larger particles traveling less distance and smaller particles traveling a longer distance (USEPA 1995). Because the recreational facilities that would be impacted by construction and demolition activities would be closed, and most dust settles quickly, aesthetic impacts from fugitive dust would be minimal and less than significant.

The Proposed Project involves the replacement of the City of Yreka water pipeline where it crosses the Klamath River. In addition, at least six bridges would need to be replaced due to structural deficiencies and/or in order to raise them above the new 100-year flood elevation. There are also culverts and roads that would need to be upgraded with new erosion and drainage control improvements (Appendix B: *Definite Plan*). The Proposed Project also involves removal of eight recreational facilities on Copco No. 1 and Iron Gate Reservoirs and modification of three other facilities. In addition, KRRC has developed a Draft Recreation Plan (Appendix B: *Definite Plan – Appendix Q*) that may result in construction of new recreation facilities. Construction activities associated with these portions of the Proposed Project would be small-scale and temporary, consistent with normal road and infrastructure maintenance activities and small construction projects. Construction activities and equipment would be seen during construction but would be temporary and would occur in already heavily disturbed areas. Therefore, they would not degrade the existing visual character of the sites or their surroundings. Similar to the other short-term potential visual impacts from construction this is considered less than significant.

Overall, because the construction activities would occur over a period of less than a year and during that time most nearby recreational facilities would be closed, the activities would not be visible to a substantial number of people, in addition to generally not being visible from any scenic vista. Furthermore, the immediate vicinities of the dams and most other construction activities are already heavily disturbed and the long term impacts will be beneficial. The short term visual impacts from construction activities are considered less than significant.

Significance
No significant impact due to construction activities

Potential Impact 3.19-7 The Project's construction or security lighting could result in new sources of substantial light or glare that would adversely affect nighttime views in the area.
Temporary lighting would be erected for nighttime construction activities during dam demolition, and security lighting might be required during deconstruction. During peak construction periods (April through November of dam removal year 2, Table 2.7-8), nighttime construction activities could occur regularly. Temporary lighting could cause glare that would adversely affect nighttime views in the area, particularly for overnight visitors and residents near the Copco No. 1 Reservoir. Because the area is rural with very little existing night lighting, and because construction lighting would be relatively intense, the impact on nighttime views would be a significant impact that would occur temporarily, until dam deconstruction was complete. No new permanent sources of light or glare would result from the Proposed Project.

The Proposed Project currently does not include measures that would reduce impacts to nighttime views cause by temporary construction lighting. KRRC proposes that KRRC and the appropriate state or local agency would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be 'good citizens' of the communities in which projects are located and thus to comply, where possible, with state and local requirements. It would be appropriate for any such terms to include measures to reduce nighttime light and glare on surrounding residences during construction. However, overseeing development and implementation of measures to reduce impacts to nighttime views does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to reach enforceable good citizen agreements that will be finalized and implemented, at this time these agreements are not finalized and the State Water Board cannot require their implementation. Accordingly, while the State Water Board anticipates that implementation of the final FERC terms and conditions for the Proposed Project would reduce potential impacts to nighttime views to less than significant, because the State Water Board cannot ensure implementation of any associated measures, it is analyzing the impact in this Draft EIR as significant and unavoidable.

Significance
Significant and unavoidable

3.19.6 References

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3.20 Recreation

This section describes the environmental setting for recreational resources, as well as potential environmental impacts and associated mitigation measures under the Proposed Project. Water quality, aquatic resources, and phytoplankton and periphyton[169] are discussed in this section only in terms of their relationship to recreation opportunities. For a detailed discussion of these resources, see Section 3.2 *Water Quality*, Section 3.3 *Aquatic Resources*, and Section 3.4 *Phytoplankton and Periphyton* of this EIR. Potential impacts to wild and scenic river segments are discussed in this section, as well as in Section 3.14 *Land Use and Planning*.

As part of the NOP scoping process, the State Water Board received several comments regarding potential recreation impacts due to Lower Klamath Project dam removal. Several commenters noted that reservoir recreational activities, including fishing, would be reduced due to dam removal, particularly at Copco No. 1 Reservoir. Many other comments anticipated an increase in river-related fishing and recreation following dam removal. Several commenters noted that Iron Gate Fish Hatchery is important for enhancing recreational fishing opportunities. Finally, one commenter questioned the future disposition of PacifiCorp properties within and adjacent to the former Lower Klamath Project reservoirs. Additional summary of the recreation comments received during the NOP public scoping process, as well as the individual comments themselves, are presented in Appendix A. Issues raised by the comments have been considered in the discussion below.

3.20.1 Area of Analysis

The Area of Analysis for recreation includes recreation areas and associated access along the Klamath River corridor from the California-Oregon border to the Klamath Estuary. Outside of the Area of Analysis for recreation, areas within and directly adjacent to the Klamath Basin, including those in Oregon, are also described to provide an overview of regional recreation opportunities and to provide a larger context for the recreational facilities that would be impacted under the Proposed Project. River reach designations are presented in Figures 2.2-2 and 2.2-3.

[169] *Phytoplankton* are defined as aquatic microscopic organisms, including algae, bacteria, protists, and other single-celled plants, that obtain energy through photosynthesis and float in the water column of still or slowly flowing waters like lakes or reservoirs. *Periphyton* are defined as aquatic organisms including algae and bacteria that live attached to underwater surfaces such as rocks on a riverbed. See Section 3.4 *Phytoplankton and Periphyton* for additional definitions related to algae.

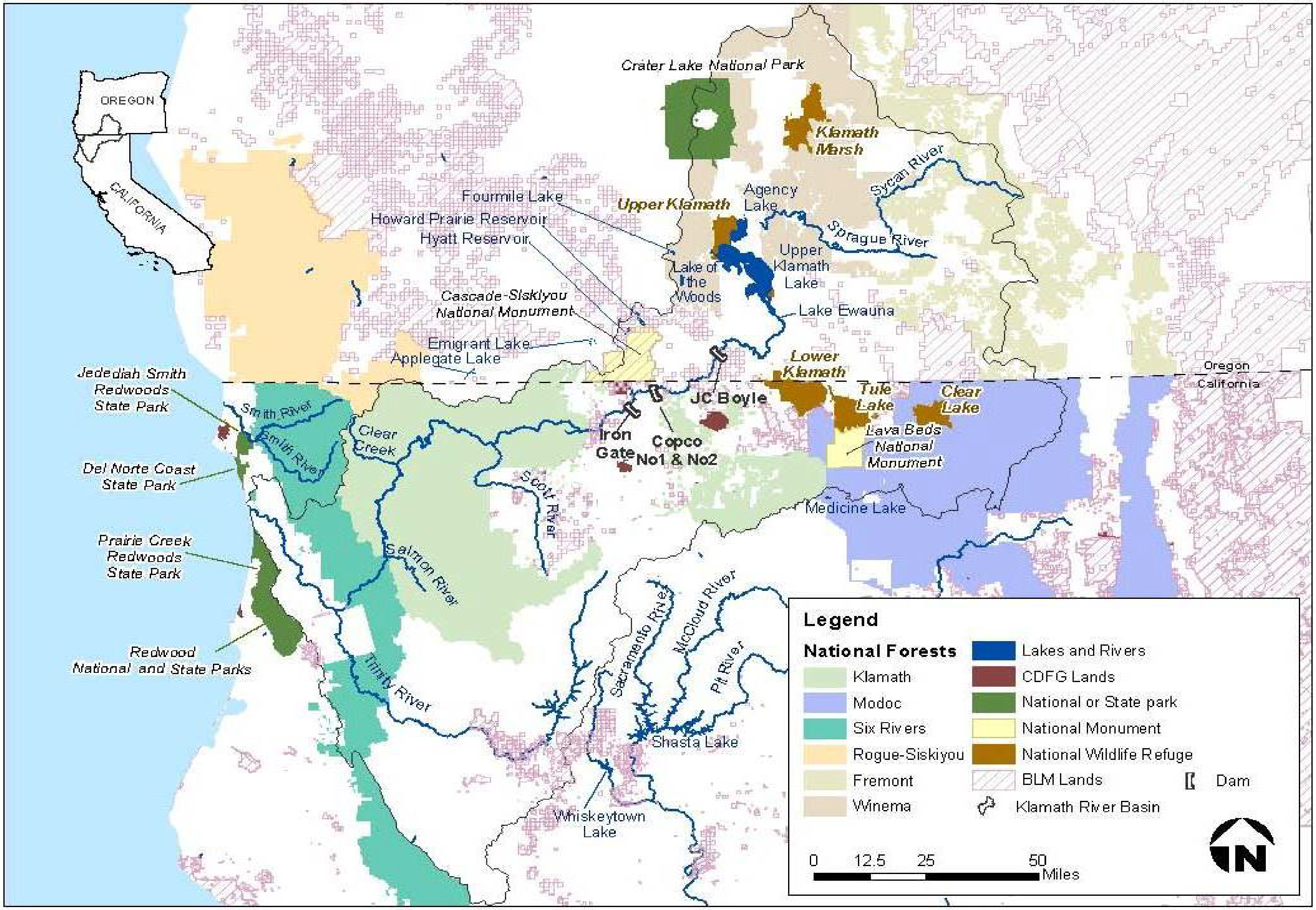

Figure 3.20-1. Area of Analysis for Klamath River Corridor and Regional Recreation Opportunities.

3.20.2 Environmental Setting

3.20.2.1 Regional Recreation

The recreational setting within the Klamath Basin is characterized by an expansive rural landscape that offers a myriad of outdoor recreational opportunities. Rivers, streams, and lakes are common throughout the mountainous landscape of the Klamath Basin, and grasslands exist in the high plateau areas of the region. Within the Klamath Basin, there are four national forests (Klamath, Fremont-Winema, Six Rivers, and Modoc), one joint national and state park (Redwood), one national park (Crater Lake), two national monuments (Lava Beds and Cascade - Siskiyou), and five National Wildlife Refuges (NWRs) (Klamath Marsh, Tule Lake, Clear Lake, Upper Klamath, and Lower Klamath), where the latter make up the Klamath Basin NWR System (Figure 3.20-1). These areas provide sightseeing, camping, hiking, fishing, boating, hunting, wildlife viewing, snow sports, off-highway vehicle uses, and other recreational opportunities. There are 297 miles of wild and scenic (under Section 2(a)ii of the Wild and Scenic Rivers Act [WSRA]) rivers in the Klamath Basin, which include segments of the Klamath, Scott, and Salmon rivers and Wooley Creek. There are also extensive public and private recreational opportunities along the Klamath River and within its reservoirs. Federal and state agencies, including the USDA Forest Service, BLM (including the Northern California District, and the Lakeview and Medford districts in Oregon), USFWS, the National Park Service (NPS), and CDFW, are responsible for managing associated lands located in Klamath and Jackson counties in Oregon, and Siskiyou County in California. Table 3.20-1 provides a summary of the opportunities offered on public lands within and adjacent to the Klamath Basin.

Table 3.20-1. Public Lands Offering Recreational Opportunities in the Area of Analysis for Recreation.

Name	Size	No. of Campgrounds	Recreational Activities Available											
			Sightseeing	Hiking	Picnic Areas	Fishing	Boating	OHV	Wildlife Viewing	Rock Climbing	Mountain Biking	Snow Play	Other	
Klamath National Forest	1.7 million acres	34	X	X	X	X	X	X	X	X	X	X	X	hunting, equestrian use, spelunking,
Fremont-Winema National Forest	2.3 million acres	40	X	X	X	X	X	X	X	X		X	X	hunting, equestrian use, backpacking, snowmobiling, leisure driving
Six Rivers National Forest	1 million acres	17	X	X	X	X	X	X	X			X		hunting, backpacking
Lava Beds National Monument	46,500 acres	1	X	X	X				X					spelunking
Crater Lake National Park	183,000 acres	2	X	X	X	X				X		X		swimming, snowshoeing, snow camping
Klamath Marsh NWR	40,600 acres	0	X			X	X		X					waterfowl hunting, photography

Name	Size	No. of Campgrounds	Recreational Activities Available											
			Sightseeing	Hiking	Picnic Areas	Fishing	Boating	OHV	Wildlife Viewing	Rock Climbing	Mountain Biking	Snow Play	Other	
Lower Klamath NWR	50,100 acres	0	X						X					waterfowl and pheasant hunting, photography, automobile touring
Upper Klamath NWR	23,100 acres	0	X		X	X	X		X					waterfowl hunting, photography
Redwood National and State Parks	132,000 (71,700 federal, 60,300 state) acres	4	X	X	X	X	X		X		X	X		Backpacking, tidepooling, bicycling, equestrian trails, scenic drives
BLM - Cascade-Siskiyou National Monument	170,400 total, (113,000 BLM) acres	4	X	X		X	X	X	X		X	X	X	snowmobiling, equestrian use, hunting
BLM - Klamath Falls Resource Area	215,000 acres	8	X	X	X	X	X	X	X			X	X	Hang-gliding, rafting, swimming, snowmobiling

Sources: BLM 1995, 2018; NPS 2018a,b,c; USBR 2012b; USDA Forest Service 2018a,b,c; USFWS 2018a,b.
Key:
OHV: off-highway vehicle
NWR: National Wildlife Refuge
BLM: Bureau of Land Management

River-based Regional Recreation

A number of rivers cross the region, including four rivers designated as wild and scenic under the WSRA (Sprague, Sycan, Smith, and Trinity rivers). Portions of the Klamath River and its tributaries (further described below in Section 3.20.2.4 *Wild and Scenic River Conditions*), are designated as wild and scenic or have been deemed suitable and eligible for listing. Designated tributaries of the Klamath River include the Salmon River, Scott River, and Wooley Creek. These rivers provide a variety of recreational opportunities, including sightseeing, fishing, and whitewater boating. Figure 3.20-1 shows the location of these rivers relative to the Klamath River. Table 3.20-2 provides a summary of the rivers, the fish species caught, and the typical types of fishing methods (e.g., boat, bank, fly). Table 3.20-3 summarizes the whitewater boating opportunities in the region. These three tables show that there are a number of recreational opportunities outside of the Proposed Project area but within the region. The Oregon Wild and Scenic Rivers, in particular, have outstanding recreational and/or scenic values along the length of the designated segments. The California Wild and Scenic Rivers are classified as wild, scenic, and recreational along the length of the designated segments (NPS 2017).

Table 3.20-2. Rivers Providing Recreational Fishing Opportunities in the Region.

River	Fish Species Caught[1]	Common Types of Fishing
McCloud River	Native trout	Fly fishing, bank fishing
Pit River	Native trout; brown trout; smallmouth bass; rough fish	Fly fishing, bank fishing
Rogue River	Chinook salmon, steelhead	Drift boat, powerboat, fly fishing
Salmon River	Chinook salmon, steelhead, resident trout	Fly fishing, bank fishing
Scott River	Chinook salmon, steelhead, resident trout	Fly fishing, bank fishing
Smith River	Chinook salmon, steelhead	Drift boat, powerboat, fly fishing, bank fishing
Trinity River	Chinook salmon, steelhead, sturgeon, American shad, lamprey	Drift boat, powerboat, fly fishing, bank fishing
Upper Sacramento	Chinook salmon, native and stocked trout, American shad	Fly fishing, bank fishing
Klamath River	Redband trout, salmon	Fly fishing, bank fishing, drift boat

Source: FERC 2007

[1] Information is based on species caught within the 2003–2004 time period.

Table 3.20-3. Rivers with Whitewater Boating Opportunities in the Region.

River	Generalized Use Levels	Boating Class Type[1]	Miles of Boatable Whitewater	Factors Affecting Use Levels
Clear Creek	Low	III–V	7	Difficult access
Klamath River (upstream of CA/OR State line)	Moderate	III–IV+	31	Remote, not suited for beginner or intermediate boaters, unless accompanied by a commercial outfitter
Klamath River (downstream from Iron Gate Dam)	Moderate	II–V	122	Most skill levels, easy access, 186 miles support multi-day floats, shoreline camping, scenery, many outfitters, commercial use
North Umpqua River	Moderate	II–IV	32	Easy access, most skill levels, scenery, boatable year-round, shoreline suitable for camping
McCloud River	Moderate	II–IV	35	Proximity to I-5, most skill levels, low flows in summer
Pit River	Low	IV–V	34	Fragmented/short runs with long stretches of flat water between, remote location
Rogue River	High	II–V	100+	Easy access, most skill levels, scenery, boatable year-round, shoreline suitable for camping, many commercial outfitters
Salmon River	Moderate	II–V	44	Requires advanced/expert boating skills, commercial use
Scott River	Low	III–V	20	Recommended for expert boaters only
Smith River	Low	II–V	100+	Requires advanced/expert boating skills, low summer flows
Upper Sacramento River	Low	III–V	36	Proximity to I-5, average solitude
Trinity River	Moderate	II–V	100+	Most skill levels, easy access, commercial use

Source: FERC 2007

[1] As rated by the American Whitewater International Scale of Difficulty (American Whitewater 2017).

Reservoir- and Lake-based Regional Recreation

Numerous opportunities for reservoir and lake-based recreation are available in the vicinity of the Proposed Project. Table 3.20-4 provides a summary of some of the comparable lakes and reservoirs in the region, including facilities and use levels. Within Klamath County and Jackson County in Oregon and Siskiyou County in California, there are more than 85 boatable lakes, containing approximately 40 boat ramps (Boat Escape 2017). The region also has more than 180 high-elevation and wilderness lakes in Siskiyou County (FERC 2007). In addition to boat ramps, these lakes provide nearly 2,300 developed campsites within a two-hour drive from the Lower Klamath Project reservoirs. Some reservoirs in the region are also stocked with trout or warm water fish such as perch or bass. Angling occurs at the many lakes and reservoirs in the region and many are known for having excellent fisheries.

Table 3.20-4. Comparison of Lower Klamath Project Reservoirs with Lakes and Reservoirs in the Region.

Lake or Reservoir	Distance from Nearest Subject Reservoir (road miles)	Surface Water (acres)	Number of Developed Campsites	Number of Developed/ Improved Boat Launches	Number of Developed Picnic Areas	Generalized Use Levels
Lower Klamath Project Reservoirs						
J.C. Boyle	N/A	420	16	2	4	Low
Copco No. 1	N/A	1,000	0	2	2	Low
Copco No. 2	N/A	40	0	0	0	Low
Iron Gate	N/A	944	37	3	6	Moderate
Other Lakes and Reservoirs in the Region						
Hyatt Reservoir	15	1,250	172	2	1	Moderate
Emigrant Lake	16	806	110	2	2	Moderate
Howard Prairie Reservoir	17	2,000	303	4	1	Moderate
Upper Klamath Lake	20	85,120	269	6	1	Moderate
Lake of the Woods	21	1,113	190	3	1	High
Fourmile Lake	26	740	25	1	0	Low
Agency Lake	28	5,500	43	3	0	Low
Applegate Reservoir	36	988	66	3	1	Low
Medicine Lake	46	408	72	1	1	Low
Gerber Reservoir	62	3,830	50	2	1	Moderate
Trinity Lake Unit	73	16,535	500	7	2	Moderate
Whiskeytown Lake	87	3,200	139	3	1	Moderate
Shasta Lake	87	29,500	320	7	7	High
Lost Creek Lake	78	3,430	202	1	2	N/A
Willow Lake	31	927	66	7	8	N/A
Willow Valley Reservoir	69	200	1	1	1	N/A
Lake Siskiyou	46	160	1			N/A
Juanita Reservoir	14	55	23	2		N/A
McCloud Reservoir	58	520	6	1	1	N/A

Source: PacifiCorp 2004; Jackson County Parks 2017; USDA Forest Service 2017

Key:
- mi: miles
- N/A: not available

A small number of developed recreation facilities exist in the Upper Klamath Basin. The following paragraphs provide brief descriptions of each facility and the recreational opportunities available, to provide further context for the regional recreational setting.

Agency Lake is connected to the northern arm of Upper Klamath Lake. Although Agency Lake has no marina, there are two public boat launches and it has a fishery that features trophy redband trout. Other popular recreational activities at the lake are sightseeing, including wildlife viewing of waterfowl (and waterfowl hunting), otter, mink, deer, and bald eagles (Southern Oregon Directory and Guide 2017). The BLM's Wood River Wetland Management Area is on Agency Lake. As shown in Table 3.20-4, a number of campgrounds surround the lake.

Upper Klamath Lake is the largest freshwater body of water in Oregon. In the northern portion of the lake, Pelican Bay is known for its population of redband trout and is an extremely popular destination for fly-fishing. The bay is also a popular location for canoeing and kayaking, as well as sightseeing and wildlife viewing. Other popular activities in Upper Klamath Lake include sailing and waterfowl hunting. As shown in Table 3.20-4, there are numerous campgrounds and boat launches surrounding the lake.

The Link River segment of the Klamath River, an approximately 1-mile stretch downstream from Link River Dam (Figure 2.4-3), has only one developed recreational facility, the Link River Nature Trail. This 1.4-mile trail is for pedestrian use only and follows a gated access road on the west side of the Link River Bypass Reach. The Link River Nature Trail is popular for sightseeing, hiking, walking, jogging, trout fishing, and bird watching (FERC 2007).

The Keno Impoundment/Lake Ewauna (Figure 2.4-3) provides various recreational opportunities, including fishing, picnicking, boating, camping, sightseeing, and wildlife viewing. In the fall, waterfowl hunting is a popular activity at Keno Impoundment/Lake Ewauna. Although most of the land adjacent to the reservoir is privately owned, Lake Ewauna has several public access areas, including the City of Klamath Falls Veterans' Memorial Park/Boat Launch, Miller Island Boat Launch, the Klamath Wildlife Viewing Area, and the Keno Recreation Area and Campground (PacifiCorp 2004). Table 3.20-5 provides a summary of the facilities and estimated annual visitation and capacity as assessed by PacifiCorp as part of relicensing studies for the Klamath Hydroelectric Project (PacifiCorp 2004).

Table 3.20-5. Keno Impoundment/Lake Ewauna Developed Recreation Facilities.

Site Name	Facilities	2001/2002 Est. Annual Use (User Days[1,2])	Est. Facility Use vs. Capacity
Klamath Falls Veterans' Memorial Park/Boat Launch (OR)	Boat launch, day-use area	42,500	Exceeding capacity
Miller Island Boat Launch and Klamath Wildlife Viewing Area (OR)	Boat launch, wildlife viewing trail, and a portable toilet	7,300	Approaching capacity
Keno Recreation Area and Campground (OR)	Campsites (26), day-use area, restrooms, boat launch and boarding dock	6,000	Below capacity

Source: PacifiCorp 2004, FERC 2007
Notes:
1 User days are defined as one visitor to a recreation area for any reason in a 24-hour period.
2 Data for PacifiCorp Klamath Hydroelectric Project Facility use was collected by PacifiCorp in 2001 and 2002. No more recently collected data exists or is available.

The Klamath Falls Veterans' Memorial Park provides a boathouse and boat launch ramp on the northern shoreline of Keno Impoundment/Lake Ewauna and is managed by the City of Klamath Falls, Department of Parks and Recreation. Along the northwestern end of the lake, the Klamath Wingwatchers Lake Ewauna Nature Trail provides opportunities for bird watching and hiking. This 1.8-mile trail connects Veterans' Memorial Park to the Link River trail, along the Link River to the north. Another trail is currently under construction on the northeastern side of the lake (Klamath Birding Trails 2017).

The Miller Island Boat Launch is on the east shore of Keno Impoundment/Lake Ewauna, approximately six miles south of Klamath Falls, and is managed by the Oregon Department of Fish and Wildlife. The facility is accessed by Miller Island Road, which runs three miles through the Klamath Wildlife Area and Miller Unit, and provides an entrance station area, parking area, wildlife viewing trail, and a portable toilet. The Keno Recreation Area and Campground on the southwestern shore of the Keno Impoundment/Lake Ewauna provides a campground, day-use area, and boat launch. The campground has 26 developed campsites, restrooms, and a recreational vehicle (RV) dump station. Recreational opportunities in this area include camping, fishing, picnicking, sightseeing, and boating. The Keno Recreation Area consists of upper and lower use areas, with the upper area adjacent to the campground and the lower area adjacent to the boat launch (FERC 2007).

3.20.2.2 Klamath River-based Recreation

Upper Klamath River and the Hydroelectric Reach

Klamath river-based recreational facilities are only considered upstream to Keno Dam (i.e., inclusive of the Upper Klamath River). Upstream of Keno Dam, due to the flat topography, the influence/slackwater of Keno Reservoir extends almost to Upper Klamath Lake (FERC 2007).

Whitewater Boating Opportunities

In Oregon, the Upper Klamath River provides approximately five miles of river suitable for Class III whitewater boating, including a flatwater paddle upstream of J.C. Boyle Reservoir, however, not much boating use is reported for this reach. The reach is rated Class III difficulty and flows acceptable for whitewater boating opportunities range from 1,000 to 4,000 cfs. The J.C. Boyle Bypass Reach includes about five miles of the Klamath River downstream from J.C. Boyle Dam and upstream of the J.C. Boyle Powerhouse. This reach provides Class III to IV+ rapids, and acceptable whitewater boating flows range from 1,300 cfs to 1,800 cfs; however, this reach is typically dewatered with only 100 to 300 cfs base flow. Therefore, the majority of the year there is almost no boating use on this stretch of the river (FERC 2007).

The Spring Island boater access is adjacent to (downstream from) the J.C. Boyle Powerhouse and is managed by BLM. This site provides car-top whitewater boat launching and shoreline fishing access. The Klamath River Campground, managed by BLM, is about three miles downstream from the J.C. Boyle Powerhouse. The campground has three developed campsites and the shoreline which can be used for fishing and boater access.

Table 3.20-6 provides a summary of acceptable flow ranges for whitewater boating and other flow-dependent recreational activities in the Klamath River (from the Upper Klamath River to the ocean).

Table 3.20-6. Acceptable Flow Ranges for Various River-Based Activities for Reaches of the Klamath River.

River Reach (Length of Reach)	Activity	Low Value (cfs)[1]	High Value (cfs)[1]
Upper Klamath River (5.0 miles)	Whitewater Boating – Standard	1,000	4,000
	Play Boating	1,100	1,800
	Fishing	200	1,500
J.C. Boyle Bypass Reach (4.3 miles)	Whitewater Boating – Standard	1,300	1,800
	Fishing	200	1,000
Hell's Corner Reach (16.4 miles)	Whitewater Boating/Kayaking[2]	1,000	3,500
	Whitewater Boating/Commercial Rafting[2]	1,300	3,500
	Fishing[3]	200	1,500
Copco No. 2 Bypass Reach (1.3 miles)	Whitewater Boating	600	1,500
	Fishing	50	600
Iron Gate to Scott River (47 miles)	Whitewater Boating/Fishing	800	4,000
Scott River to Salmon River (76 miles)	Boating	800	7,000
	Fishing	800	4,000

River Reach (Length of Reach)	Activity	Low Value (cfs)[1]	High Value (cfs)[1]
Salmon River to Trinity River (23.1 miles)	Whitewater Boating/Fishing	800	10,000
Trinity River to Ocean (43.4 miles)	Whitewater Boating/Fishing	1,800	18,000

Source: Appendix R of USBR 2012b
Notes:
[1] Values were determined by the Secretarial Determination Recreation Sub-team (2010) from relicensing documents (PacifiCorp 2004; FERC 2007) and consultation with USDA Forest Service and BLM representatives.
[2] Flows are within the desirable range during the daily peak hydroelectric operations period (between 10:00 AM and 2:00 PM).
[3] Flows are within the desirable range for at least 4 hours during the daily non-peak hydroelectric operations period (either between 5:00 AM and 11:00 AM or between 3:00 PM and 9:00 PM).
Key:
cfs: cubic feet per second

Within California, whitewater boating opportunities are provided on the Hell's Corner Reach of the Klamath River Hydroelectric Reach, and the Copco No. 2 Bypass Reach. The Hell's Corner Reach from J.C. Boyle Reservoir to Copco No. 1 Reservoir extends about 16.4 river miles. Several public fishing and boat access areas exist along this reach, as summarized in Table 3.20-7. A 2002 recreation survey indicated that whitewater boating is the most common activity among respondents between J.C. Boyle Dam and Copco No. 1 Reservoir (PacifiCorp 2004).

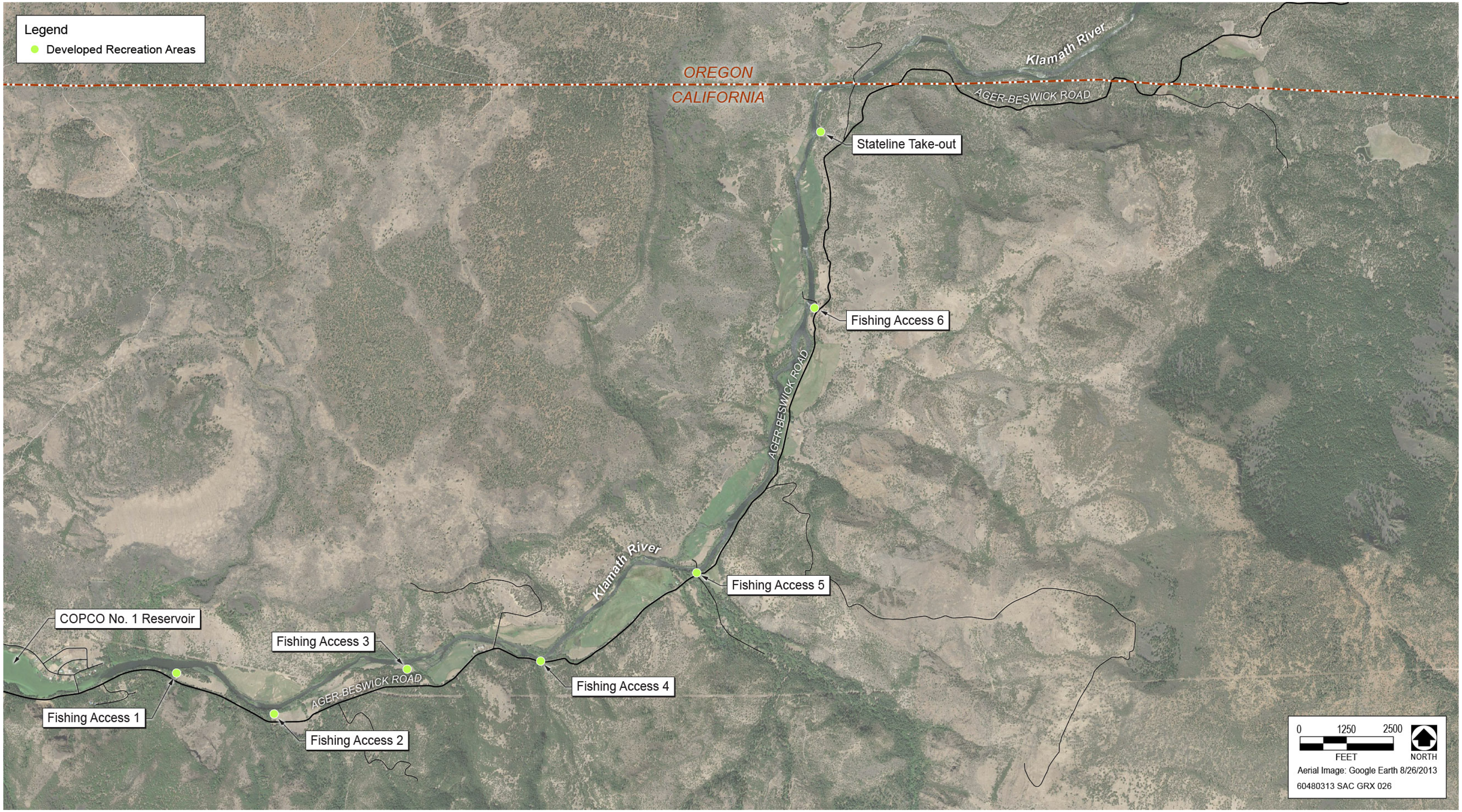

Figure 3.20-2a. California Stateline to Copco No. 1 Reservoir Recreation Area. Data source: PacifiCorp 2004. Map from AECOM (unpublished).

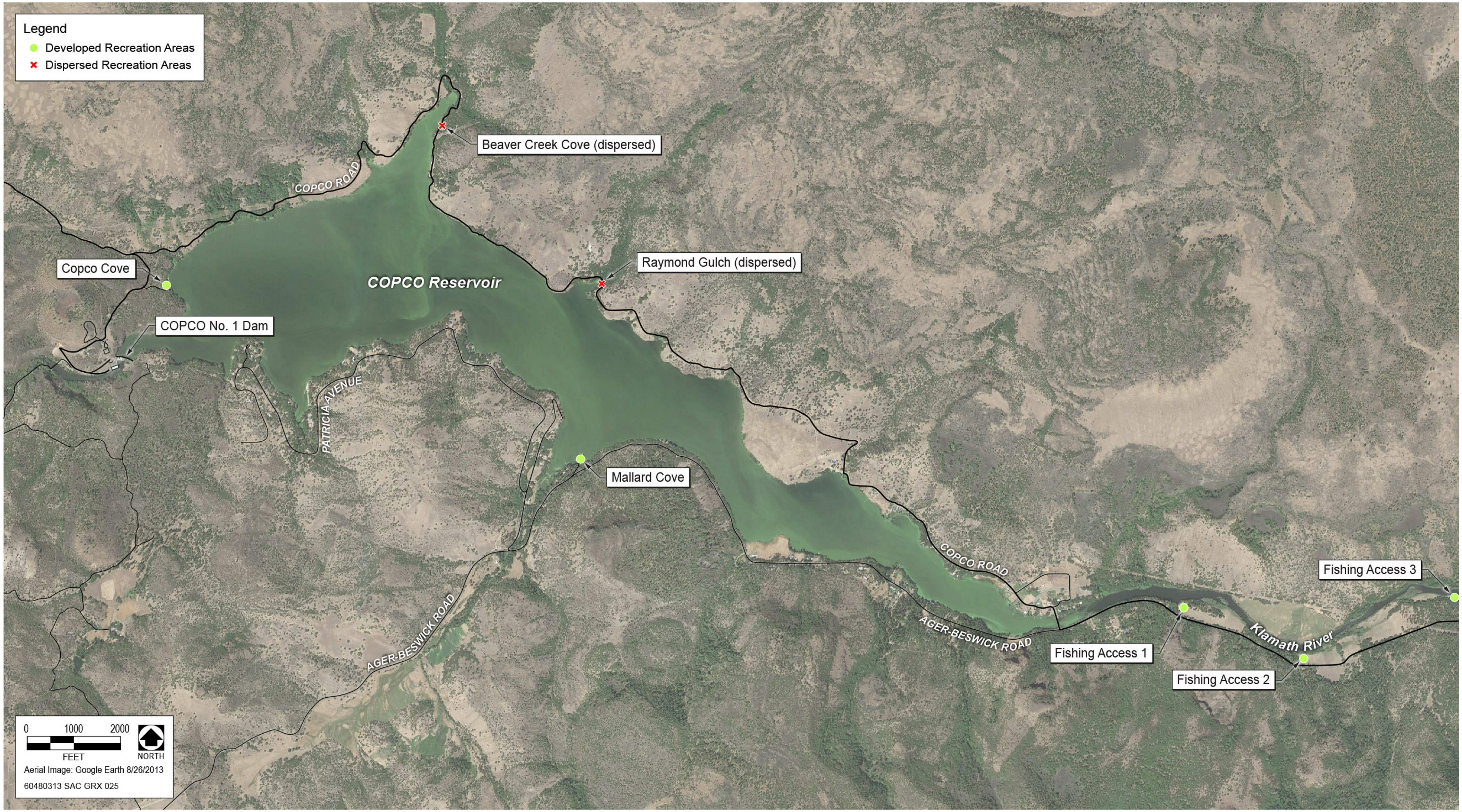

Figure 3.20-2b. Copco No. 1 Reservoir Recreation Area. Data source: Reclamation 2011. Map from AECOM (unpublished).

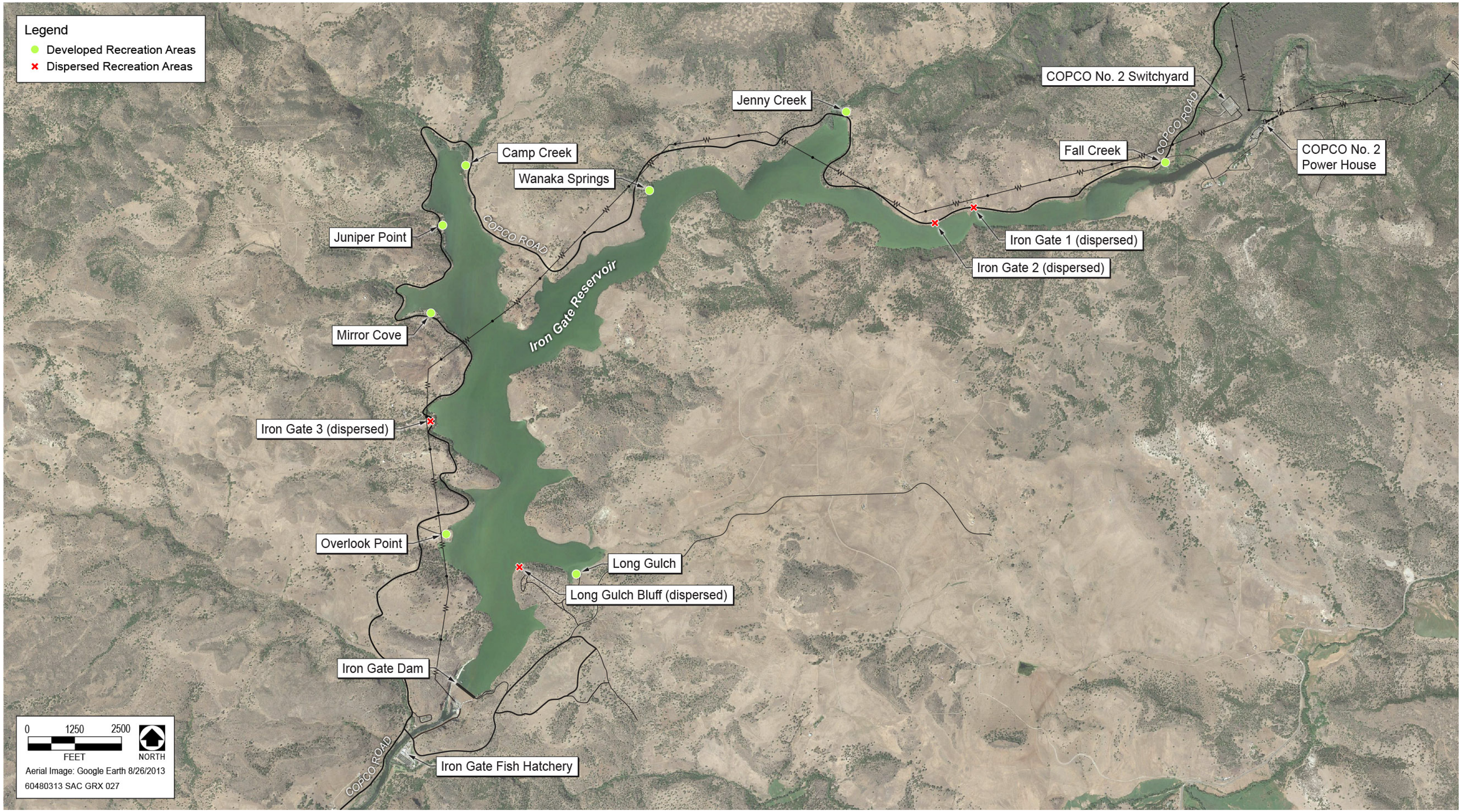

Figure 3.20-2c. Iron Gate Recreation Area. Data source: PacifiCorp 2004. Map from AECOM (unpublished).

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Table 3.20-7. Hell's Corner Reach Developed Recreation Facilities.

Site Name	Facilities	2001/2002 Est. Annual Use (Recreation days)	Est. Facility Use vs. Capacity
Spring Island Boater Access	Launch area, shoreline fishing access, restrooms	5,200	Below capacity
Klamath River Campground	Campsites (3), shoreline fishing and boating access, restrooms	1,000	Below capacity
Stateline Take-out	Boat put- in/take-out, shoreline fishing access, restrooms	2,700	Approaching capacity
Fishing Access Sites 1–6	Shoreline fishing access, parking	3,600	Below capacity

Source: PacifiCorp 2004, FERC 2007

The State line take-out access area of the Hell's Corner Reach, at the Oregon/California State line, includes upper and lower areas and is co-managed by BLM and PacifiCorp. The facility provides shoreline fishing and boat launching access. The fishing access sites provide access to the Klamath River in six locations between the State line take-out access area and Copco No. 1 Reservoir.

BLM manages whitewater boating use in the Hell's Corner Reach, a 16.4-mile reach from below J.C. Boyle Reservoir to the Fishing Access Site 1 take-out (see Figure 3.20-2a). This reach provides Class III to IV+ rapids during daily peaking flows from the PacifiCorp hydropower operations (between 10:00 AM and 2:00 PM), and acceptable whitewater boating flows range from 1,300 cfs to 3,500 cfs for commercial rafting and heavier loaded boats. Acceptable minimum flows for kayaking and private boaters are 1,000 cfs. Outside of the daily peaking flows, flow rates within this reach do not meet the acceptable range to create or enhance whitewater boating opportunities.

The average estimated annual whitewater boating use from 1994 through 2009 on this reach was 4,414 recreation days, peaking in the mid-1990s at around 6,000 recreation days per year. Whitewater boating use occurs typically during April through October, with about 80 percent of the commercial rafting use occurring during July through September. Commercial boating use accounted for about 93 percent of the whitewater boating use on this reach (DOI 2011).

Commercial boating use is allowed by permit only. There is a set commercial capacity of 10 outfitters or 200 clients per day on this reach. There is no limit for private boating capacity, although BLM has established 250 persons per day as the overall whitewater boating carrying capacity of the reach. Factors that constrain the carrying capacity of the reach are vehicle congestion at the take-out locations near Copco No. 1 Reservoir and the limited size and number of areas that are available to scout rapids (FERC 2007).

The Copco No. 2 Bypass Reach is approximately 1.3 miles long, extending from Copco No. 2 Dam to the Copco No. 2 Powerhouse and whitewater boating opportunities are limited due to lack of flow. However, the reach could provide Class IV whitewater opportunities at acceptable flows ranging from 600 to 1,400 cfs (Appendix S.

Fishing Opportunities
In Oregon, fishing is allowed from September 30 until June 16 on the Klamath River downstream from Link River Dam. The highest use in this area occurs from late winter through spring; this area is mainly used by Klamath Falls residents. At lower flow times, anglers use the river at a few sites where there is access for bank fishing through thick riparian vegetation. Catch records indicate that although angler success is consistently low, there is a greater percentage of larger fish caught in the upstream reach than between J.C. Boyle Dam and the state line. Table 3.20-6 summarizes flows acceptable for fishing opportunities in the various reaches of the Klamath River.

PacifiCorp conducted a visitor use survey in 2002 to obtain information on existing visitor demand, needs, and recreational activities within the area between J.C. Boyle Reservoir and Iron Gate Dam. The results of the survey indicated that 33 percent of visitors to the area participate in bank fishing, both along the river and reservoirs. Survey respondents also indicated that fishing for trout on river reaches in this area is considered very good, and one of the two most popular reaches for fishing opportunities includes the J.C. Boyle Bypass Reach downstream from J.C. Boyle Dam. Opportunities for trout fishing also exist downstream of J.C. Boyle Powerhouse (Hell's Corner Reach). This reach (between J.C. Boyle Powerhouse and the state line) is popular with anglers, and catch records indicate good angler success, although fish size is typically smaller than fish caught below Keno Dam and rarely exceeds 16 inches (FERC 2007).

Recreational opportunities downstream from Hell's Corner Reach, between the California/Oregon state border and Iron Gate Dam, are quite popular for angling. In 1974, a 6-mile reach of the Klamath River, from the California/Oregon state line to Copco No. 1 Reservoir (not including tributaries), was designated as Wild Trout Waters by the State of California and is managed under the Wild Trout Program (CDFG 2010) (see also Section 3.3 *Aquatic Resources*). Demand for recreational angling is high in this area. However, the Klamath River between the Copco No. 1 and Iron Gate developments has limited public access and no documented fishing activity.

In California, the Lower Klamath Project dams impound three waterbodies on the Klamath River: Copco No. 1, Copco No. 2, and Iron Gate reservoirs. Since Copco No. 2 is small with a surface area of only about 40 acres and contains no recreational facilities, the discussion focuses on Iron Gate and Copco No. 1 reservoirs. In addition to these reservoirs, there is a stretch of un-impounded river between the California-Oregon state line, and Copco No. 1 Reservoir. There is also a small (approximately 1.5-mile) stretch of river in between Copco No. 2 Dam and Iron Gate Reservoir. Figures 3.20-2(a), (b), and (c) show the locations of these waterbodies, and Section 3.20.2.3 *Lower Klamath Project Reservoir-based Recreation* describes recreational opportunities at each of these areas.

Middle and Lower Klamath River
The USDA Forest Service (Klamath and Six Rivers National Forests) manages the majority of the Klamath River corridor from downstream from Iron Gate Dam to the confluence with the Trinity River. Other areas downstream from Iron Gate Dam are also managed by the NPS, BLM, tribes, and private landowners. Table 3.20-8 summarizes the river-based recreational opportunities available on the Klamath River downstream of Iron Gate Dam.

Table 3.20-8. River-Based Recreation Opportunities in the Middle Klamath River, Between Iron Gate Dam and the Confluence with the Trinity River.

Reach	Length (miles)	Current Recreation Opportunities
Iron Gate Dam to Shasta River	13	Sightseeing, fishing (especially from boats), tubing and swimming, whitewater boating (rare), waterplay
Shasta River to Scott River	34	Sightseeing, fishing, canoeing, whitewater boating, locational playboating, waterplay
Scott River to Indian Creek	36	Sightseeing, fishing, canoeing, whitewater boating, waterplay
Indian Creek to Salmon River	40	Sightseeing, fishing, whitewater boating, canoeing, hiking, waterplay
Salmon River to Trinity River	40	Sightseeing, fishing, waterplay

Source: PacifiCorp 2004

There are two privately developed recreation facilities located along the Middle Klamath River a few miles downstream of Iron Gate Dam. The R Ranch Klamath River Campground is located a few miles east of Cottonwood and I-5 and 2.5 miles downstream from Iron Gate Dam along 1.7 miles of the Middle Klamath River. This campground contains 156 campsites with a large lodge/recreation center and provides opportunities to fish, hunt, and view natural scenery and wildlife. And the Klamath Ranch Resort Blue Heron RV Park is located along the Klamath River 1.5 miles downstream of Iron Gate Dam. This campground features 26 campsites, several accessory structures, a fly-fishing school casting pond, historic restaurant, and boat launch.

There are several other private land areas near the I-5 corridor, in Seiad Valley, at Happy Camp, and near the mouth of the Salmon River at Somes Bar. In general, these areas have several homes and associated, sparsely populated, rural development. These areas have considerable opportunities to camp, swim, picnic, or relax along this portion of the Klamath River. There are also some opportunities for sightseeing, hiking, walking, or biking along the river. In addition, there are some popular short hikes from the river up the tributaries, such as Ukonom and Clear Creek. Land-based recreation points along the river are generally near developed access points for boaters and anglers and a few developed USDA Forest Service and private campgrounds (PacifiCorp 2004).

In addition, there are two National Forest Scenic byways located along this segment of the river and within the Klamath and Six Rivers National Forests. The “State of Jefferson” National Forest Scenic Byway is located primarily on California State Highway 96 (State Highway 96) between Shasta River to Happy Camp, and the “Bigfoot” National Forest Scenic Byway is located on Highway 96 from Happy Camp to California State Highway 299 (State Highway 299). There is also an “All America Road,” the Volcanic Legacy Scenic Byway, which goes from Lassen National Park in California and through the project area via Highways 97, 140, and 62 on its way to Crater Lake National Park in Oregon. These byways provide excellent views for sightseers within the Klamath and Six Rivers National Forests and access to numerous other recreational activities (America’s Scenic Byways 2017).

Downstream of the Trinity River confluence, the Lower Klamath River flows through the Yurok, Hoopa, and Resighini Indian Reservations and Redwood National Park, as well as through public lands managed by the BLM and privately-owned lands. A number of private RV and tent campgrounds are along the river in Redwood National Park, and just outside of the park in the City of Klamath. These campgrounds provide opportunities for bank fishing, camping, and picnicking. Other recreation opportunities in the area are associated with Redwood National and State Parks, which includes Jedediah Smith, Del Norte Coast, and Prairie Creek Redwood state parks and Redwood National Park, which offer hiking, hunting, wildlife viewing, and other recreational opportunities. (See Table 3.20-1 for a summary of the facilities associated with these parks.)

Public Health Issues

As discussed in Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*, concentrations of chlorophyll-*a* and *Microcystis aeruginosa* have exceeded World Health Organization guidelines for protection from adverse effects in recent years, in both Copco No. 1 and Iron Gate reservoirs, as well as reaches of the Klamath River downstream from Iron Gate Dam. In 2005, 2008, 2009, 2010, 2012, 2013, 2014, 2016, and 2017, the North Coast Regional Board, Karuk Tribe, Yurok Tribe, USEPA, and other local, state, and federal agencies issued warnings to residents and recreational users of the reservoirs and river to use caution near these algal blooms due to possible health effects of exposure to *Microcystis aeruginosa* and its microcystin toxin (Kann and Corum 2006, Kann and Corum 2009, North Coast Regional Board 2009, 2010, 2012a, 2013, 2014, 2016, 2017a). Effects range from mild, non-life-threatening skin conditions to permanent organ impairment and death, depending upon exposure time and intensity (FERC 2007). As identified in comments received during the scoping period for the 2012 KHSA EIS/EIR, as well as in PacifiCorp's recreation survey in 2002, these water quality issues and public health warnings have resulted in reduced recreational activity in affected river segments in recent years.

Whitewater Boating Opportunities

Extensive whitewater boating opportunities exist downstream from Iron Gate Dam. Depending on the river segment and level of flow, there are opportunities for play, standard, and big water boating on Class II and III waters (American Whitewater 1998). These runs are boatable in rafts, kayaks, inflatable kayaks, and open canoes. Table 3.20-6 summarizes the acceptable flow ranges for all reaches within the area of effect, including downstream from Iron Gate Dam.

Although not as challenging as the Hell's Corner Reach upstream, there are a few rapids that are sometimes rated Class IV, including Hamburg and Upper Savage on the Otter's Playpen run, Rattlesnake on the day-use run below Happy Camp, and Dragon's Tooth between Ferry Point and Coon Creek Access. There is also a well-known kayak playboating wave known as the "School House Wave" between Skehan Bar and Gottville. This wave is typically available during low to moderate summer flows and is popular with local kayakers from the Mount Shasta, Klamath Falls, and Ashland areas (PacifiCorp 2004). There is also a Class V-VI rapid at Ishi Pishi Falls (Somes Bar) that boaters are strongly advised to portage around due to its cultural significance to local tribes (American Whitewater 2017).

The primary whitewater boating season is in summer (June through August), when water temperatures are warm; however, the Klamath River can be boated in most months of the year (PacifiCorp 2004). There is less whitewater rafting downstream from the Trinity

River confluence after the river turns northwest into strong prevailing winds. There are fewer developed river access points along this reach than in the reaches upstream. This reach is located within the boundaries of the Yurok Tribe Indian Reservation. Data collected by the USDA Forest Service and BLM indicate that substantially more whitewater boating occurs on the Klamath River downstream of Iron Gate Dam than in the Klamath River upstream to J.C. Boyle Dam. From 1994 through 2009, the average annual number of user days was 14,392 per year. However, whitewater boating in this portion of the Klamath River has decreased somewhat in recent years. Total user days from 2000 through 2003 ranged from 13,976 to 15,349 per year, whereas from 2005 through 2009, total user days ranged from 11,751 to 15,279 per year (DOI 2011).

Fishing Opportunities

The Klamath River downstream from Iron Gate Dam has high quality angling opportunities extending nearly 200 miles to the Pacific Ocean and is open to fishing year-round. This reach, designated a wild and scenic river (see Section 3.20.2.4 *Wild and Scenic River Conditions* below), attracts and supports several fishing outfitter services that focus on salmon, steelhead, and trout fisheries. A review of outfitters conducted as part of the Secretarial Determination process identified over 50 outfitters providing sport fishing, boat fishing, and/or fly-fishing trips on the Klamath River. Twenty-seven river access sites within the Klamath National Forest provide access for fishing in this section of the river. Use at the sites varies; however, most are rated as light usage (Klamath National Forest 2017). Tables 3.20-9 and 3.20-10 provide recent use data for Chinook salmon and steelhead fishing on the Klamath River. As shown in Table 3.20-9, angler success for Chinook salmon varied annually, but was generally greater in the first half of the decade than in the latter half. The USDA Forest Service reported that the decline in fish production in the past few decades triggered a similar decline in the guide and resort industry, as well as sport fisheries (FERC 2007).

Table 3.20-9. Estimated Number of Recreational Salmon Angler Days[1] and Chinook Salmon Harvest on the Klamath River (excluding the Trinity River), 2001–2015.

Year	# Angler Days	Chinook Salmon Harvest (# Fish)		
		Adults	Grilse (Jacks)	Total
2001	28,251	9,621	1,365	10,986
2002	24,993	9,769	651	10,420
2003	23,259	7,322	589	7,911
2004	24,751	3,463	2,293	5,756
2005	17,789	1,029	912	1,941
2006	12,141	57	5,202	5,259
2007	19,597	4,975	257	5,232
2008	15,249	1,560	4,039	5,599
2009	20,755	4,820	2,033	6,853
2010	16,219	2,610	1,570	4,180
2011	Not available	3,019	8,738	11,757
2012	Not available	11,837	3,802	15,639
2013	Not available	18,628	2,212	20,840
2014	Not available	4,464	3,190	7,654
2015	Not available	7,798	1,580	9,315

Year	# Angler Days	Chinook Salmon Harvest (# Fish)		
		Adults	Grilse (Jacks)	Total
01–05Avg	23,809	6,241	1,162	7,403
06–10Avg	16,792	2,804	2,620	5,425
11–15Avg	NA	9,149	3,904	13,053

Source: CDFW 2016; NMFS 2011
Notes:
[1] Angler days are defined by USBR as the time spent fishing by one person for any part of a day.

Table 3.20-10. Estimated Number of Recreational Steelhead Angler Days on the Klamath River (excluding the Trinity River), 2003–2008.

Year	# Angler Days
2003	19,183
2004	14,345
2005	13,216
2006	19,371
2007	15,622
2008	21,192
03-08Avg	17,155

Source: NMFS 2011

Downstream from the Trinity River confluence, angling in the Klamath River is dependent on the annual status of the fall-run Chinook salmon run, so the number of businesses that offer angling guide services varies from year to year with the Chinook salmon population size. The main run of Klamath River Chinook salmon peaks in late fall and is normally over by mid-January each year; the steelhead season generally starts in November and runs through March (see also Section 3.3 *Aquatic Resources*).

Anglers fish from boats and the bank. Most of the boat fishing occurs from drift boats or rafts. Fishing regulations allow anglers to keep up to five trout per day and most of the fishing activity occurs in summer and fall. Quotas and limits on salmon and steelhead have varied over the years, and regulations may depend on whether the fish are wild or from a hatchery. Most anglers catch and release steelhead (PacifiCorp 2004).

3.20.2.3 Lower Klamath Project Reservoir-based Recreation

As there are no reservoirs located on the Klamath River downstream of Iron Gate Dam, the following discussion of reservoir-based recreation focuses on the Lower Klamath Project reservoirs located in the Hydroelectric Reach from J.C. Boyle Reservoir to Iron Gate Dam.

Hydroelectric Reach

J.C. Boyle Reservoir

J.C. Boyle Reservoir has a surface area of approximately 420 acres and is about 3.6 miles long. Developed public recreational facilities at the reservoir include Pioneer Park, Sportsman's Park, and Topsy Campground (Table 3.20-11). See Appendix B: *Definite Plan - Appendix C,* Figure 5.1-1, Sheets 2-3, for locations of these recreational facilities.

Table 3.20-11. J.C. Boyle Reservoir Developed Recreation Facilities.

Site Name	Ownership	Facilities	2001/2002 Est. Annual Use	Est. Facility Use vs. Capacity
Pioneer Park	PacifiCorp	Picnic areas, boat launches, interpretive signs, restrooms	16,700	Below capacity
Topsy Campground	BLM	Campsites (16), an RV dump, two day-use areas, a boat launch with boarding dock, an accessible fishing pier, restrooms	5,600	Below capacity
Sportsman's Park	Klamath County	Shooting ranges, dirt racetracks, archery courses, a model aircraft flying field, off-highway vehicle area, restrooms	12,600	Below capacity

Source: PacifiCorp 2004, FERC 2007

Pioneer Park is owned and operated by PacifiCorp and it lies off Oregon State Highway 66 (State Highway 66) east and west of Spencer Bridge. Pioneer Park is a day-use area that provides picnic areas, boat launches, interpretive signs, and two restroom facilities. It has an improved boat ramp on the east shore just off State Highway 66, and a picnic area and unimproved boat launch on the west shore. Popular activities at this location include sightseeing, boating, fishing, swimming, and picnicking (PacifiCorp 2004).

Topsy Campground is managed by BLM. The campground is south of State Highway 66 off Topsy Grade Road, a gravel road maintained on an as-needed basis by BLM, private owners, timber companies, and PacifiCorp. This site features a campground with 16 sites, an RV dump, two day-use areas, a boat launch with boarding dock, an accessible fishing pier, and two restroom facilities. The campground is available to the public and BLM charges fees for day-use and camping at this facility (PacifiCorp 2004).

Sportsman's Park, approximately 0.25-mile east of the reservoir, is a multi-use recreation area owned by Klamath County and leased long term to Klamath Sportsman's Park Association. The park does not provide developed reservoir access, but it does provide river access for fishing. The park contains shooting ranges, dirt racetracks, archery courses, and a model aircraft flying field. The park also has facilities for self-contained RVs and some tent camping. Annual membership passes and single-day passes for use of the park are available to the general public for a fee (PacifiCorp 2004, Sportsman's Park 2017).

In California, the Lower Klamath Project dams impound three waterbodies on the Klamath River: Copco No. 1, Copco No. 2, and Iron Gate reservoirs. In addition to these reservoirs, there is a stretch of un-impounded river between J.C. Boyle Reservoir and Copco No. 1 Reservoir. Figures 3.20-2(a), (b), and (c) show the locations of these reservoirs, and the following sections describe recreational opportunities at each of these areas.

Copco No. 1 Reservoir

Copco No. 1 Reservoir, with a surface area of approximately 1,000 acres and about 4.5 miles long, has two publicly available day-use facilities—Mallard Cove and Copco Cove—that are owned and operated by PacifiCorp. These facilities provide day-use access to the reservoir, and although they are not official campgrounds, camping occasionally occurs at both locations. Copco No. 1 Reservoir currently provides a recreational fishery for non-native fishes including largemouth bass, trout, catfish, crappie, sunfish, and especially yellow perch (Hamilton et al. 2011). Table 3.20-12 summarizes the existing facilities and estimated use during 2001/2002 at both of these areas.

Table 3.20-12. Copco No. 1 Reservoir Developed Recreation Facilities.

Site Name	Facilities	2001/2002 User Days[1,2]	Est. Facility Use vs. Capacity
Mallard Cove	Picnic area, restrooms, boat launch with boarding dock	7,600	Below capacity
Copco Cove	Picnic area, restrooms, boat launch with boarding dock	1,250	Below capacity

Source: PacifiCorp 2004, FERC 2007

Notes:

[1] User days are defined as one visitor to a recreation area for any reason in a 24-hour period. Estimated use was during the 2001/2002 study period (PacifiCorp 2004).

[2] Although annual user data from 2001/2002 represent the most comprehensive information available, these data were collected prior to data characterizing seasonal blue-green algae blooms in Iron Gate Reservoir became available (see also Section 3.4.2.3 *Hydroelectric Reach*) and prior to the freshwater CyanoHABs Program that began posting of public health advisories for California reservoirs that exceed algal toxin thresholds.

Mallard Cove, on the south shore of Copco Reservoir, is accessed off Ager-Beswick Road and includes day-use facilities, two restrooms, and a boat launch with boarding dock. Copco Cove, on the western shoreline of Copco Reservoir, off of Copco Road, has a small picnic area, two restrooms, and a boat launch with boarding dock (PacifiCorp 2004).

Additionally, homes on Copco Lake provide private recreational access, including docks for fishing, boating, swimming and birdwatching.

Copco No. 2 Reservoir

Copco No. 2 Reservoir is relatively small (with a surface area of approximately 40 acres and about 0.3-mile long) and has a narrow configuration with steep and difficult shoreline access. Copco No. 2 Reservoir has no recreational facilities and no public access (FERC 2007).

Iron Gate Reservoir

Iron Gate Reservoir has a surface area of approximately 944 acres and is 6.8 miles long. The reservoir has the highest concentration of recreation sites of all the developments associated with the PacifiCorp facilities. The developed facilities at Iron Gate Reservoir are owned and managed by PacifiCorp and include a trail (Fall Creek Trail), five combination day-use and campground areas (Jenny Creek, Camp Creek, Juniper Point, Mirror Cove, and Long Gulch), three day-use areas (Fall Creek, Overlook Point, and

Wanaka Springs), and a fish hatchery and associated day-use area (Iron Gate). Recreational opportunities include sightseeing, swimming, fishing, boating, and day and overnight use. Iron Gate Reservoir currently provides a recreational fishery for non-native fishes including largemouth bass, trout, catfish, crappie, sunfish, and especially yellow perch (Hamilton et al. 2011). Summer and weekend use is high at the reservoir due to the popularity of bass tournaments, waterskiing, and camping. Table 3.20-13 summarizes the developed recreation facilities at the reservoir and PacifiCorp's estimated annual recreation visitation and capacity during the 2001/2002 study period.

The Fall Creek Day-Use Area is at the upper end of the reservoir and includes a picnic area, boat launch access, and restroom facilities. This small day-use area is adjacent to the CDFW Fall Creek Fish Hatchery and provides access to Fall Creek Trail. Fall Creek Trail is a short (0.1-mile) trail located adjacent to the Fall Creek Fish Hatchery where visitors can hike up to Fall Creek Falls.

Wanaka Springs Day-Use Area provides picnic areas, a fishing dock, restroom facilities, and some informal camping occurs in the area.

Table 3.20-13. Iron Gate Reservoir Developed Recreation Facilities.

Site Name	Facilities	2001/2002 Est. Annual Use (User days)[1]	Est. Facility Use vs. Capacity
Fall Creek Day-Use Area and Fall Creek Trail	Picnic area, boat launch access, restrooms, hiking trail	4,150	Below capacity
Overlook Point	Restrooms	1,900	Below capacity
Wanaka Springs Day-Use Area	Fishing dock, restrooms	4,150	Exceeding capacity
Jenny Creek Day-Use Area and Campground	Campsites (6), restrooms	3,700	Approaching capacity
Camp Creek Day-Use Area and Campground	Campsites (13), boat launch, boarding and fishing docks, swimming area, a RV dump station, sports field, interpretive display restrooms	15,250	Exceeding capacity
Juniper Point Day-Use Area and Campground	Campsites (9), a fishing dock, restrooms	4,700	Exceeding capacity
Mirror Cove Day-Use Area and Campground	Campsites (10), a boat launch, restroom	11,140	Exceeding capacity
Long Gulch Day-Use Area and Campground	Picnic sites, boat launch, restrooms	5,200	Below capacity
Iron Gate Fish Hatchery	Picnic area, picnic shelter, visitor center/interpretive kiosk, restrooms, trail to river	2,200	Below capacity

Sources: PacifiCorp 2004, FERC 2007

[1] Although annual user data from 2001/2002 represent the most comprehensive information available, these data were collected prior to data characterizing seasonal blue-green algae blooms in Iron Gate Reservoir became available (see also Section 3.4.2.3 *Hydroelectric Reach*) and prior to the freshwater CyanoHABs Program that began posting of public health advisories for California reservoirs that exceed algal toxin thresholds.

Overlook Point is on the west side of the reservoir, approximately 0.75-mile upstream of Iron Gate Dam. The facility has picnic sites on moderately steep topography, providing a good view of the reservoir and surrounding landscape.

Jenny Creek Day-Use Area and Campground includes six day-use/campsites and a restroom facility. Jenny Creek is on the north side of the reservoir and provides a creekside setting for picnicking and bank fishing.

Camp Creek Day-Use Area and Campground is along a narrow reach on the north side of Iron Gate Reservoir. The surrounding hilly, semi-arid landscape and the reservoir provide pleasant views. Camp Creek Campground has several campsites designed primarily for RV campers, with a large overflow RV/tent camping area. The facility also has picnic sites, a sports field, and boat docks/fishing piers.

Juniper Point Day-Use Area and Campground has several picnic areas (occasionally used as campsites), a fishing dock, and restroom facilities.

Mirror Cove is a day-use area and campground centrally located on the west side of the reservoir. The area offers several picnic sites (occasionally used as campsites), a boat launch, and restroom facilities. This particular location is popular for group camping and is used extensively by local water-ski clubs. This boat launch is the nearest access to a competitive water-ski course placed in the western area of the reservoir.

Long Gulch Day-Use Area and Campground is on the east side of the reservoir directly across from Overlook Point. Facilities at this location include picnic sites, restroom facilities, and a boat launch. Land along an adjacent ridge is occasionally used for dispersed camping and day-use (PacifiCorp 2004).

Immediately downstream of Iron Gate Dam, the Iron Gate Fish Hatchery is operated by CDFW and includes a public day-use area adjacent to the hatchery and an undeveloped boat launch across the river from the hatchery. The day-use area includes a picnic area, a picnic shelter, visitor center/interpretive kiosk, restroom facilities, a trail to the river, and seasonal interpretive tours. Fishing is prohibited in this area as well as within 3,500 feet downstream from the dam.

Visitor Use and Perception

PacifiCorp conducted a visitor survey in 2004 to assess recreational use and visitor perceptions of recreational facilities, including the Lower Klamath Project reservoirs. The majority of visitors surveyed (approximately 60 percent of total) were from Klamath County and Jackson County, Oregon. The remaining visitors were from California (approximately 40 percent of total), approximately half of which came from Siskiyou County (approximately 20 percent of total). When asked to indicate all activities participated in while visiting the Lower Klamath Project reservoirs, more than half of the visitors' surveys included resting/relaxing as one of the activities. When surveyed on their perception of crowding at the reservoirs, the mean score of respondents was 3.2 (on a 9-point scale from 1—not crowded to 9—extremely crowded), indicating that visitors did not feel overly crowded while participating in recreation activities. Further, approximately 39 percent of respondents had changed their visits to the Lower Klamath Project reservoirs from other lakes in the area to avoid crowding. When surveyed regarding management options of the reservoirs, survey respondents indicated opposition to the collection of user fees at either day-use sites or facility campgrounds (PacifiCorp 2004).

In response to the survey question "Has water quality ever affected your visit to the Klamath River area?" approximately two-thirds of recreational users of the Lower Klamath Project reservoirs had negative perceptions of water quality, commenting on its color, turbidity, and odor. The source of visitor concerns was primarily the brown, foamy water in free-flowing reaches and regular, extensive phytoplankton [algae] blooms that occur throughout the reservoirs. Visitors reported that the phytoplankton [algae] produces bad odors, fouls fishing lines, and reduces the area available for fishing, swimming, and wading (FERC 2007).

3.20.2.4 Wild and Scenic River Conditions

Two segments of the mainstem Klamath River are designated wild and scenic rivers, one in Oregon and one in California (Figure 3.20-3). The reach in Oregon, between the J.C. Boyle Powerhouse and the Oregon-California state line was designated a wild and scenic river in 1994. As this section is not in California, it is not analyzed in this EIR.

In California, the entire river beginning 3,600 feet downstream of Iron Gate Dam to the Klamath Estuary (i.e., Middle and Lower Klamath River) is designated a wild and scenic river segment by both the State of California and the federal government. Wild and scenic river segment boundaries include variable-width linear corridors which typically include not more than 320 acres per linear mile (averaging up to approximately 0.5 mile in width along the river corridor). However, some protections for designated outstanding remarkable values can extend beyond the boundaries.

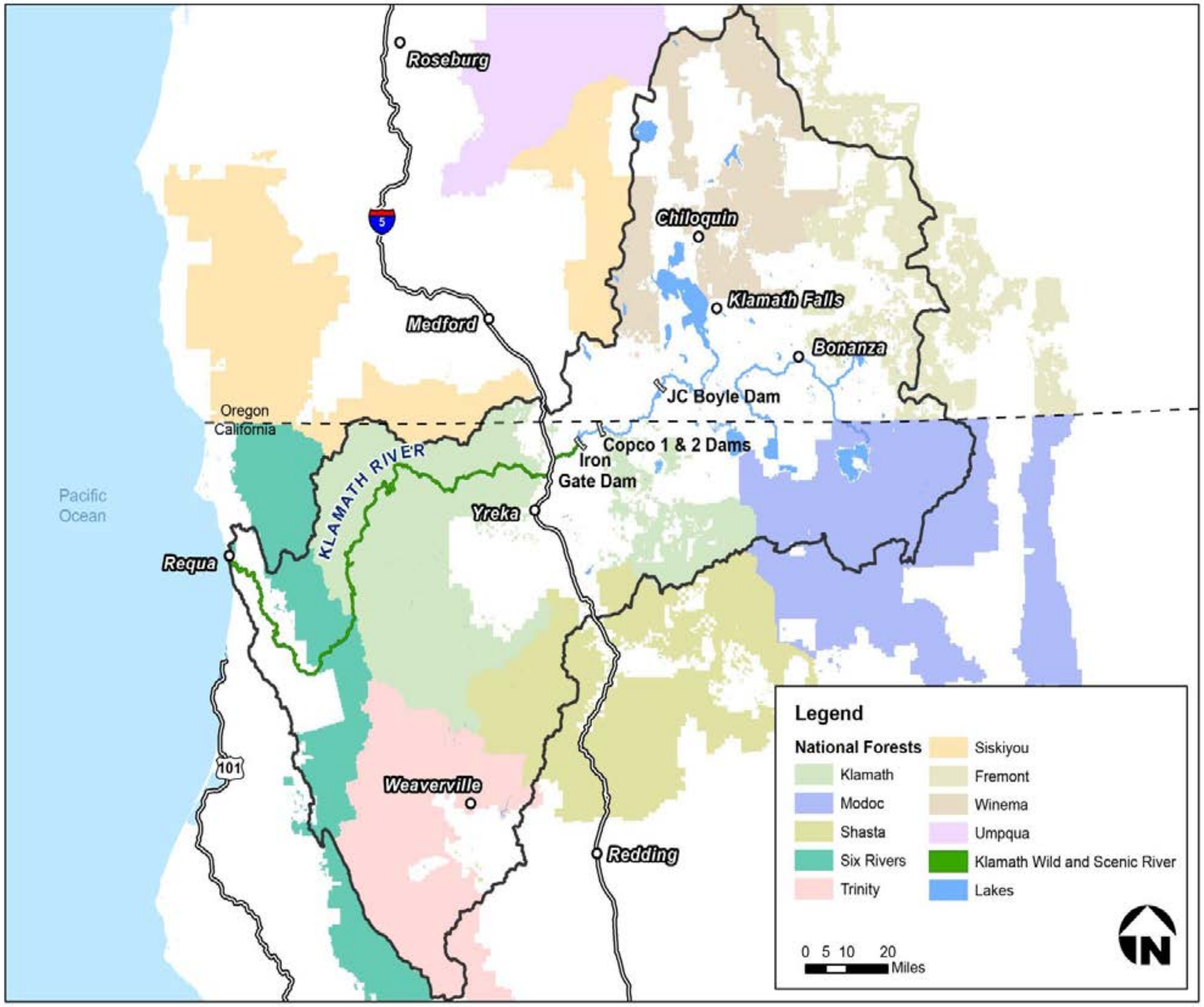

Figure 3.20-3. Klamath Wild and Scenic River Corridor.

California Klamath River Wild and Scenic River Segment

The segment of the Klamath River in California, as well as portions of three tributaries (Salmon and Scott rivers and Wooley Creek), were added to the National Wild and Scenic River System in 1981 through Section 2(a)(ii) of the WSRA. The wild and scenic river portion of the mainstem Klamath River in California is classified as recreational with portions of the tributaries classified as scenic and wild. At the time of listing, the anadromous fishery, including salmon and steelhead, was considered to have the outstandingly remarkable value for the entire 286 miles of the designated segment, which includes the tributaries. For the purposes of evaluating the potential impacts of the Proposed Project on the wild and scenic qualities of this river segment, the following subsections summarize the conditions of the river at the time of the wild and scenic river designation, as well as changes to the condition of the river since the time of the designation that have affected its wild and scenic character.

Scenic Character

Scenery within the wild and scenic river segment of the Klamath River in California is dominated by natural settings. This segment's characteristic river flows, water appearance, anadromous fish, and riparian vegetation within a forested river canyon are the primary scenic aspects. Since 1981, flow regimes have varied moderately in response to water resource competition within the Klamath Basin. During summer months, these variations have typically been caused by water diversions (Van de Water et al. 2006). Copco No. 1 and Iron Gate reservoirs serve as the major sources of large seasonal phytoplankton blooms with the first documented toxic bloom in 2004 (see also Section 2.6 *Project Background* and Section 3.4.2.3 *Hydroelectric Reach*), which when transported into downstream reaches of the Middle and Klamath River reduce water clarity, cause discoloration, and result in surface scums that impair the historic scenic character of the river downstream from Iron Gate Dam. Extensive seasonal periphyton mats that colonize bottom surfaces in the Middle and Lower Klamath River , (see also Section 3.4.2.4 *Middle and Lower Klamath River*) can also result in water coloration, cloudiness, and limitations on depth of view. The level of reduced water clarity, discoloration, limitations on depth of view, and resulting scenic quality effects is dependent on viewer location. Views from on-river, in-river, or riverside viewpoints are most likely to display substantial changes to scenic quality indicators, while these changes are less likely to be noticed as viewed from nearby river canyon roadways and communities.

Similarly, seasonal and project-induced changes in flow and resulting scenic quality changes are more likely to be observed by on-water, in-water, and riverside viewpoints than nearby river canyon roadways and community viewpoints. The scenic quality of the river changes with different flow levels; more banks and mid-channel rocks are visible during low flows. The lowest monthly mean flows on the Klamath River occur in the summer (July and August), which also tends to coincide with the highest visitorship rates. Monthly mean flows below Iron Gate Dam (USGS Gage #11516530) in July and August have generally ranged from around 700 cfs to 1,100 cfs, with a few exceptions in drought years and wet years (USGS 2017). With the exception of 17 months between 1991 and 2004, flows have not dropped below 700 cfs since the dam was built; since 2004, flows have not dropped below 800 cfs (Van de Water et al. 2006 and USGS 2017).

Recreation

Before and since the wild and scenic designation, the flows released from Iron Gate Dam have greatly influenced the downstream Klamath River summer recreation season's whitewater boatability, challenge levels, safety hazards, potential for equipment damage, and the opportunity to access and experience the river's full range of rapids and channels. Exceptionally low summer time flow releases are especially adverse to wild and scenic river boating activities on the Klamath River. Table 3.20-14 compares flows at the time of the 1981 designation to flow conditions required for whitewater boating and recreational fishing (see Table 3.20-6 for optimal flow ranges) (Van de Water et al. 2006).

Table 3.20-14. Comparison of 1981 Flows to the Acceptable Range for Whitewater Boating and Fishing.

Month	Flows (cfs)	Whitewater Boating	Fishing
January	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
February	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
March	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
April	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
May	1,000	In acceptable boating flow range/optimal playboating range	In optimal range
June	710	Does not meet minimum boatable flow or playboating opportunities	Does not meet minimum fishing flow
July	710	Does not meet minimum boatable flow or playboating opportunities	Does not meet minimum fishing flow
August	1,000	In acceptable boating flow range/optimal playboating range	In optimal range
September	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
October	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
November	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
December	1,300	In acceptable boating flow range/optimal playboating range	In optimal range

Source: Van de Water et al. 2006

Key:

cfs: cubic feet per second

Although precise estimates of available recreation days in 1981 are not available, commercial recreational whitewater boating activity on the Klamath River within the Klamath National Forest, increased by approximately 34 percent between 1981 and 2005 (Van de Water et al. 2006). However, commercial activity on the Lower Klamath River has decreased somewhat since 2005 from a recorded 10,695 user days to 8,230 user days in 2009. Private recreational whitewater boating activity has followed a similar pattern, with the greatest number of user days between 1995 and 2005 (ranging from

4,193 to 5,230) and decreasing since 2005 to a low of 3,525 user days in 2009 (DOI 2011).

Water Quality

Water quality influences recreational use and it is one of the criteria considered in a Wild and Scenic River designation. Water quality issues have existed since the time of wild and scenic river designation and there is evidence indicating that these issues may have increased since that time (Kann and Corum 2009, Asarian and Kann 2011, Asarian and Kann 2013). Data collected in the past five years provides further evidence water quality issues continue to persist (Watercourse Engineering, Inc. 2012, 2013, 2014, 2015, 2016). Water quality issues in the Klamath River, including phytoplankton blooms and microcystin toxin from blue-green algae [cyanobacteria], affect river recreation users (also see discussions in Section 3.20.2.2 *Klamath River-based Recreation*, and Section 3.20.2.3 *Lower Klamath Project Reservoir-based Recreation*). Monitoring of blue-green algae [cyanobacteria] species that produce algal toxins conducted by the Karuk Tribe between 2005 and 2007 at 16 nearshore stations in the Klamath River downstream of Iron Gate Dam indicate that nearly 60 percent of samples taken between June and September exceeded the moderate risk level as defined by the World Health Organization (Kann and Corum 2009). Sampling conducted in 2007 shows that microcystin toxin is found as far downstream as the Yurok Reservation, near the river mouth (Kann 2006). In recent years, high levels of microcystin concentrations have continued to be measured during summer months in Copco No. 1 and Iron Gate reservoirs with the microcystin concentrations exceeding the state recommended threshold in recreational waters in most years since 2008 (North Coast Regional Board 2009, 2010, 2012a, 2013, 2014, 2016, 2017a). Microcystin concentrations in the reservoirs and much of the Klamath River exceeded the “Danger Tier II” threshold in August/September 2017 (North Coast Regional Board 2017). In addition, the entire length of the Klamath River’s wild and scenic river section in California currently does not meet North Coast Regional Board water quality objectives for temperature during certain times of the year (North Coast Regional Board 2017b; Watercourse Engineering, Inc. 2012, 2013, 2014, 2015, 2016; Asarian and Kann 2013). Water temperature in the Klamath Basin varies seasonally, with mean monthly temperatures in the river immediately downstream from Iron Gate Dam peaking at approximately 20 to 22.5°C (68 to 72.5°F) in July and August (Asarian and Kann 2013). Daily mean and daily maximum water temperatures during summer typically increase with distance downstream from Iron Gate Dam due to meteorological controls until between Seiad Valley and Orleans, then, as the Klamath River approaches the coast, the daily mean and daily maximum water temperatures decrease with distance downstream due to the influence of cooler coastal air temperatures as well as incoming flow from cooler tributaries such as the Salmon and Trinity rivers (Basdekas and Deas 2007, Asarian and Kann 2013). A detailed description of existing water quality is provided in Section 3.2.2 *Environmental Setting* and Appendix C.

Fisheries

The Klamath River was designated a wild and scenic river from3,600 feet downstream of Iron Gate Dam to the mouth because of its free-flowing condition and its outstandingly remarkable anadromous fisheries, including that of salmon and steelhead trout. Even at the time of designation, decreasing salmonid trends in the Klamath River system were identified as being affected by various factors, including dam construction and operations related to hydropower generation in the Klamath River (Snyder 1931; DOI 1980; see also Section 3.3.2.1 *Aquatic Species*). Such factors have resulted in increased summer water temperatures, changed the natural flow regime, decreased dissolved oxygen levels in portions of the river, and blocked access to more than 350 miles of anadromous salmonid spawning, incubation, and rearing habitat.

Fisheries and the associated fisheries wild and scenic river conditions in the Klamath River are also affected by the coarse sediment deficit resulting from sediment trapping in the Lower Klamath Project developments, which has resulted in coarsening of the channel bed and a reduction in the size and frequency of mobile coarse sediment deposits in a limited downstream channel extent. Because tributaries downstream of Cottonwood Creek supply most of the coarse sediment to the mainstem Klamath River under both unimpaired and current conditions, the effects of reservoir sediment trapping are limited to the reach between J.C. Boyle Reservoir and approximately the Scott River. As discussed for fisheries resources in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*, reduced coarse sediment delivery to this reach has reduced the amount and quality of spawning gravel deposits and disrupted the geomorphic processes that create and maintain aquatic habitats (Buer 1981, PacifiCorp 2004). Although the reach downstream of Iron Gate Dam was historically a prime spawning area, by 1981 the reach produced few salmon and the riffles within the reach contained cobbles too large for salmon to move. Prior to the construction of Iron Gate Dam and the 1981 wild and scenic river designation, the reach between Iron Gate Dam and Shasta River was scoured by daily peak flows from Copco No. 1 and Copco No. 2 operations (Van de Water et al. 2006).

Given the findings of the 2006 study, it appears that much of the riverbed coarsening had occurred prior to the wild and scenic river designation (Van de Water et al. 2006). However, impacts from dams progress over time so continued sediment depletion (by the retention of sediment behind the dams) is expected to continue to worsen spawning habitat below Iron Gate Dam (Ligon et al. 1995, Kondolf 1997, Grant et al. 2003).

River flows also affect fisheries' population and abundance. Table 3.20-14 shows the monthly flows at the time of the Klamath River's wild and scenic river designation. Flows are a key component of cumulative effects from water management on the aquatic environment. The flow regime downstream from Iron Gate Dam affects aquatic resources through instream flow influences on physical habitat (depth, velocity, substrate, and cover) and on water quality that may affect the prevalence of disease pathogens (Bartholow et al. 2005). See Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* for a discussion of the Klamath River flows under the Proposed Project.

Estimates of abundance for anadromous fisheries in California at the time of the wild and scenic river designation are not available for all species. Table 3.20-15 provides estimates of abundance at the time of designation, or as near as possible to the time of designation for those species for which data is available. As discussed in Section 3.3.2.1 *Aquatic Species*, the abundance of anadromous fisheries has decreased since the time of the wild and scenic river designation. Specific units of coho salmon in the Klamath River were listed as threatened under the ESA in 1997. Similarly, green sturgeon was listed by NMFS as a Species of Concern in 2005 and designated as threatened under the ESA in 2010. The resident (i.e., non-anadromous) Lost River and shortnose suckers endemic to the Upper Klamath Basin of southern Oregon and northern California were designated as endangered in 1988 after the wild and scenic river designation.

Table 3.20-15. Estimated Abundance of Fish Species at the 1981 Wild and Scenic River Designation.

Species	Estimated Abundance
Fall Chinook salmon	Natural spawners – 4,000 (1981)
	Iron Gate hatchery spawners – 21,595 (1981)
Coho salmon	3,400 (1984)
Summer Steelhead	110,000 (average 1977–1991)
Winter Steelhead	20,000 (average 1977–1991)

Source: Van de Water et al. 2006

Wildlife

Wildlife populations have not been systematically surveyed on the Klamath River. Baseline data were not collected in 1981; therefore, population numbers or trends are not available for most species in specific areas like the wild and scenic river corridor.

Riparian vegetation provides habitat for feeding, breeding, and sheltering for willow flycatchers, western pond turtles (a species of special concern in California), and various other wildlife species along the Klamath River. There is no reference condition for the riparian vegetation in 1981 (Van de Water et al. 2006). The Proposed Project area and the area within the Klamath River corridor includes a large number and diversity of wildlife species. Surveys conducted by PacifiCorp in 2002 and 2003 identified five amphibian species, numerous bird species, including 19 species of birds of prey, and numerous mammal species, including black-tailed jackrabbit, mule deer, and California ground squirrels. See Section 3.5 *Terrestrial Resources* for further discussion of wildlife populations within the Klamath River corridor.

Eligible and Suitable Wild and Scenic River Section on the Klamath River

In 1990, BLM found the 5.3-mile section of the Klamath River from the California-Oregon state line to the slack water of Copco No.1 Reservoir to be eligible and suitable for wild and scenic river designation under Section 5(d)(1) of the WSRA. The river segment is free-flowing and possesses outstandingly remarkable scenic, recreational, fish, and wildlife values. This river segment is not a designated wild and scenic river and is not protected under the WSRA and its Section 7(a) requirements. The BLM is required, within its authorities, to protect this suitable river segment's free-flowing character, water quality, and outstandingly remarkable river values. This segment of the Klamath River is also listed on the Nationwide Rivers Inventory (NPS 2009). If a river is listed in the Nationwide Rivers Inventory, the federal agency involved with the action must consult with the land managing agency in an attempt to avoid or mitigate adverse effects of any proposed water resources projects. This consultation is required pursuant to a directive from the Council on Environmental Quality.

3.20.3 Significance Criteria

Criteria for determining significance on recreational opportunities are based on Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and professional judgement. As the Appendix G checklist questions for recreational impacts are limited, two additional criteria were added for this EIR as there is potential for impacts on a variety of users and uses under the Proposed Project.

Impacts from the Proposed Project would be considered significant if any of the following criteria are met:

- Changes to or loss of rare or unique recreational facilities affecting a large area or substantial number of people.
- Significant increase in the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facilities would occur or be accelerated.
- Construction of new or expansion of existing recreational facilities which might have an adverse physical effect on the environment.
- Affect identified resource values in a wild and scenic river segment (i.e., scenic, recreational, fish, and wildlife) such that the long-term wild and scenic river designation or eligibility for listing would be compromised.

3.20.4 Impact Analysis Approach

The impact analysis for recreational resources considers the potential implications of the Proposed Project on changes to river- and reservoir-based recreation opportunities, activities, and settings within the Area of Analysis. Short-term and long-term effects on access, flow-dependent recreational activities, recreational fishing, and other recreational activities associated with the existing Klamath River corridor and reservoir recreational facilities within the Area of Analysis are described. The relocation of the City of Yreka's water supply pipeline is not expected to result in any impacts to recreational resources; therefore, it is not addressed in this section of the EIR.

3.20.4.1 Recreational Setting, Facilities, and Access

Likely changes to recreational use and access were assessed qualitatively, including changes from reservoir-based recreational opportunities to more river-based opportunities in the areas where the Lower Klamath Project dams, recreational facilities, and/or PacifiCorp facilities would be removed. The short-term effects analysis includes a discussion of potential areas where recreational access would be restricted during construction activities. The assessment of long-term effects considers potential changes in the recreational setting and experience, changes in water quality and reservoir area revegetation for Klamath River-based recreational opportunities, as well as potential impacts on regional recreational facilities due to increased use.

3.20.4.2 Whitewater Boating Opportunities

Optimal and acceptable flows for whitewater boating opportunities along reaches of the Klamath River were assessed as a part of the technical review completed for the Proposed Project. The range of acceptable flows resulted from the Final Technical Report, Klamath Hydroelectric Project (PacifiCorp 2004). Flow values that fall within these ranges are considered acceptable flow levels for the various activities (see Table 3.20-6).

Hydrologic modeling was used to assess changes in the availability of acceptable flows under the various alternatives. The modeling results for each water year type were subjected to a statistical analysis (paired T-tests) to determine whether the difference in number of days meeting the acceptable range of flows following dam removal (both on an annual and monthly basis) would be statistically significant. A qualitative approach was used to assess the effects of the identified alternatives on whitewater boating access and existing whitewater boating opportunities.

3.20.4.3 Recreational Fishing Opportunities

The results of the hydrologic modeling were used to: determine whether changes in flow would affect recreational fishing opportunities (i.e., the number of days with optimal flows for recreational fishing); qualitatively assess potential changes in fisheries populations and abundance; and determine effects of changes from reservoir-based fishing opportunities to river-based opportunities.

3.20.4.4 Other Recreational Opportunities

The analysis also includes an assessment of other recreational activities, such as sightseeing, swimming/wading/tubing, fish and wildlife viewing, and camping that occur within the river corridor and a qualitative discussion of the effects of the various alternatives on these activities. The discussion here covers both anticipated short-term effects, such as construction-related effects, and long-term effects, such as changes in reservoir-based swimming opportunities.

3.20.4.5 Wild and Scenic Rivers

Evaluation criteria for each of the four protected resources specified in the WSRA Section 7 (a) (i.e., scenic, recreational, fish, and wildlife) have been developed to assess the effects of the Proposed Project as compared with conditions at the date of the Klamath River's designation into the National Wild and Scenic Rivers System (see Section 3.20.2.4 *Wild and Scenic River Conditions*). The type (positive or negative) and duration (short term or long term) of the effects are described, and the magnitude of these effects is analyzed. The effects are characterized as unchanged, beneficial, or adverse (or similar conclusion), by value (i.e., scenic, recreational, fisheries, and/or wildlife), for that resource.

Scenery was evaluated using the following criteria:

- Water flow character (river flows and accompanying river width, depth, and channel inundation or exposure)
- Water appearance (clarity, turbidity, depth of view, color, prominence of phytoplankton and periphyton)
- Fish and wildlife viewing
- Riparian vegetation
- Natural appearing landscape character (the visual effects of facilities and structures as viewed from within the designated wild and scenic river corridor)

Recreation was evaluated using the following criteria:

- Whitewater boating
- Recreational fishing
- Other recreational activities (water play, swimming, camping)
- Recreational setting (water quality related aesthetic odors, tastes, contacts, and public health and safety aspects)

Fishery was evaluated using the following criteria:

- Stream flow regime
- Water temperature
- Water quality (physical, biological, and chemical)
- Aquatic habitat (geomorphic condition, sediment transport regime, and substrate quality)
- Fish species population conditions, specifically:
  - Anadromous salmonid fish species
  - Resident fish species
  - Species traditionally used and culturally important to Native Americans

Wildlife was evaluated using the following criterion:

- Changes in habitat for affected species

3.20.5 Potential Impacts and Mitigation

Potential Impact 3.20-1 Effects on existing recreational facilities and opportunities due to access restrictions, noise, dust, and/or sediment release resulting from construction activities.

Construction activities associated with dam removal would result in temporary loss of access to recreational facilities at the Lower Klamath Project reservoirs and associated reservoir-based recreational opportunities. Access could remain restricted for an additional period following completion of dam removal as restoration activities are conducted on the former reservoir area and existing recreational areas are modified to accommodate the new river channel. However, as described above in Section 3.20.2.1 *Regional Recreation*, a number of reservoirs, lakes, and rivers are present within and adjacent to the Klamath Basin and provide similar opportunities for recreational activity. Therefore, temporary impacts on recreational access in the vicinity of Iron Gate and Copco No. 1 reservoirs would be less than significant.

As described in Potential Impact 3.9-1 and Potential Impact 3.23-1, the use of heavy vehicles and equipment during dam removal activities, and to a much lesser degree during restoration, would result in increases in dust and ambient noise in the vicinity of the Proposed Project. These activities will primarily occur over a period of approximately one and a half years; however, in any one location, there will generally be less than six months of nuisance generating activities (see Table 2.7-1). These increases could indirectly result in a decrease in the quality of recreational experiences at nearby facilities that would not have restricted access during construction (e.g., river access, trails, and private parks not directly affected by construction and reservoir drawdown). Specific effects related to dust and noise during construction are discussed in detail in Potential Impact 3.9-1 and Potential Impact 3.23-1, respectively.

With regard to recreational activities, increases in ambient noise and air pollutants could impede visitors' ability to rest and relax, and disrupt bird and wildlife viewing opportunities. These effects would last for the duration of demolition activity and during initial restoration activities. However, as shown in Figures 3.20-2(a-c), the majority of recreation facilities and access points at the Lower Klamath Project reservoirs and along the Hydroelectric Reach are located a fair distance away from the Lower Klamath Project dams and would continue to provide opportunities for recreation until drawdown is completed. Because noise and dust impacts decrease with increasing distance from the source, impacts at these recreational facilities will be minimal. Further, as described in Section 3.20.2.1 *Regional Recreation*, numerous other recreational facilities are available outside the area of affect, but within the vicinity of the Iron Gate and Copco No. 1 reservoirs that provide similar recreational opportunities (Table 3.20-4). Therefore, these temporary noise and dust impacts would be less than significant.

As discussed in Potential Impact 3.2-3, drawdown of the reservoirs would result in short-term increases in turbidity (also expressed as suspended sediment concentration) downstream from the Lower Klamath Project reservoirs. Elevated turbidity would be most pronounced immediately downstream from Iron Gate Dam to Bogus Creek and it would become less noticeable farther downstream due to dilution from tributary flows entering the Klamath River. Modeling of suspended sediment concentrations during drawdown indicates suspended sediment concentrations would decrease to 60 to 70 percent of the initial value by Seiad Valley (RM 132.7) and to 40 percent of the initial value downstream of Orleans (approximately RM 59). Turbidity in the Klamath River is anticipated to flush through the system relatively quickly, but elevated turbidity is conservatively anticipated to occur for six to ten months following drawdown based on modeling of suspended sediment concentrations (USBR 2012a). Sediment jetting would occur during drawdown maximize erosion of accumulated sediments during this period and potentially reduce turbidity after drawdown concludes, and immediate revegetation will occur to further minimize the potential for prolonged increases in turbidity. Turbidity in the Klamath River is expected to resume natural background levels by the end of post-dam removal year 1 regardless of the water year type based on modeling of suspended sediment concentrations (USBR 2012a) (see Potential Impact 3.2-3 for more details).

The increase in turbidity would reduce visibility for boaters, swimmers, and fishermen during the sediment flushing period and could result in reduced public participation for these activities (e.g., swimmers might be less likely to enter the river, and fishermen might be less successful due to the reduced water clarity). Increased turbidity would also affect swimmer safety considerations if swimmers are unable to see the river bottom or navigate around obstacles, such as large boulders or logs beneath the water surface. However, impacts would be temporary; following completion of reservoir drawdown activities, water quality and clarity would be expected to improve as sediments are flushed downstream and into the Pacific Ocean. Due to naturally high levels of turbidity in the river during winter flows, increased turbidity from the Proposed Project would not be noticeable for most of the drawdown period. In addition, turbidity impacts primarily would occur for a period of approximately six to ten months, with turbidity decreasing with distance downstream of Iron Gate Dam due to dilution from tributary flows entering the Klamath River. Turbidity would likely be only slightly above or similar to natural background turbidity in the Klamath River downstream of Seiad Valley (RM 132.7) by mid-May following drawdown based on a comparison of model SSCs during drawdown and natural background SSCs, except during dry water year types when turbidity may remain above natural background turbidity until after September (USBR 2012a). While opportunities for fishing and swimming in the vicinity of the Klamath River, including the area where Copco No. 1 and Iron Gate reservoirs are located, would be reduced during the drawdown period when these recreational activities would typically be low, opportunities for fishing and swimming in the Klamath

River downstream of Seiad Valley (RM 132.7) during the deconstruction period would be similar or slightly reduced compared to existing conditions since turbidity would only be slightly above or to similar to natural background turbidity levels during most water year types. Additionally, opportunities for fishing and swimming would remain available in tributaries of the Klamath River during both drawdown and deconstruction. As such, the Proposed Project would not result in changes to or loss of rare or unique recreational facilities affecting a large area or substantial number of people; therefore the impacts are less than significant.

Sediment release could also decrease the quality of water-contact-based recreational opportunities if sediment released downstream resulted in longer-term deposition in pools, eddies, slack water, and beaches and decreased the availability of these areas for recreational activity. As discussed in Potential Impact 3.11-5, modeling was conducted to determine the potential for such deposition following dam removal activities. The results of the modeling indicate that following dam removal activities, short-term deposition of fine and coarse sediment would occur primarily between Iron Gate Dam and Cottonwood Creek and average river bed elevation would change (i.e., increase or decrease) by up to 1 foot (see Figure 3.11-15). The Proposed Project was developed to allow reservoir drawdown to occur during winter months when precipitation, river flows, and turbidity are naturally highest. Suspended sediment concentrations would be highest during the period of greatest reservoir drawdown (January through mid-March of dam removal year two), as erodible material behind the dams is mobilized downstream (see also Potential Impacts 3.2-3 and 3.11-6). During normal to dry water years, suspended sediment concentrations would begin to decline in late March and would continue declining through early summer. If it is a wet year, it may take longer to drain the reservoirs and the high concentrations may extend until June. Suspended sediment concentrations would return to near background conditions for all water year types within the first year following removal (see also Potential Impact 3.2-3). Therefore, it is unlikely that sediment release would decrease the availability of pools, eddies, or beaches for recreational activity, even temporarily, and impacts on the quality of water contact-based recreational opportunities would not be- significant.

Overall, the impacts of construction and restoration activities are limited in temporal and geographic scope and so would not result in changes to or loss of rare or unique recreational facilities affecting a large area or substantial number of people. Nor would they result in a significant temporary increase in the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facilities would occur or be accelerated. Tables 3.20-2, 3.20-3, and 3.20-4 show that there are numerous alternative recreational facilities and access outside the area of affect, but within the vicinity. Most of these facilities experience low to moderate use levels and they can accommodate additional users. Recreational users who are temporarily displaced would be able to use these other areas, but they are unlikely to overload the other areas because those areas have sufficient capacity to accept them. Therefore, impacts will be less than significant.

Significance

No significant impact

Potential Impact 3.20-2 Long-term changes to or loss of reservoir-based recreation activities and facilities due to removal of Iron Gate and Copco No. 1 reservoirs. The removal of Iron Gate and Copco No. 1 reservoirs under the Proposed Project would eliminate existing opportunities for reservoir-based recreation activities, such as power boating, waterskiing, lake swimming, and flat-water boat angling. Copco No. 2 Reservoir is very small and has no recreational facilities or access. As discussed in Section 3.20.2.3 *Lower Klamath Project Reservoir-based Recreation*, Iron Gate and Copco No. 1 reservoirs are popular recreational areas for sightseeing, fishing, camping, swimming, boating, and wildlife viewing, and they attract visitors primarily from the surrounding communities in Klamath and Jackson counties, Oregon and Siskiyou County, California. As indicated in the responses to visitor use surveys conducted by PacifiCorp (2004), the reservoirs are popular recreation areas in part because they are uncrowded relative to other lakes in the area and do not require user fees. Some activities associated with reservoir recreation could still be possible in the restored river channel (e.g., swimming and wading). However, due to increased flows, certain reservoir-based recreation such as swimming opportunities and flat-water boating may be limited in the restored river channel during certain times of year and in wet water years.

Thus, under the Proposed Project there would be a long-term loss of local reservoir-based recreational activities at Iron Gate and Copco No. 1 reservoirs, but there would be no change from existing conditions in reservoir-based recreational activities at Copco No. 2 since it has no recreational facilities or access.

However, a number of other lakes and reservoirs are in the vicinity of the Lower Klamath Project reservoirs and provide similar opportunities for recreation in an uncrowded setting (Table 3.20-4). Specifically, Fourmile Lake, Agency Lake, Applegate Reservoir, and Medicine Lake, located from 26 to 46 miles away from the Lower Klamath Project reservoirs, each have generally low-use levels as well as similar or greater surface area, a greater number of developed campsites, and a similar number of improved boat launches compared with Iron Gate and Copco No.1 reservoirs (PacifiCorp 2004). As described in Section 3.20.2.1 *Regional Recreation* (in particular, see Table 3.20-4), there are more than 85 boatable lakes in Klamath and Jackson Counties in Oregon and Siskiyou County in California that are within 100 miles of the Lower Klamath Project reservoirs and provide similar facilities and activities. The Lower Klamath Project reservoirs only account for less than 1.5 percent of the surface area of the regional lakes, 2.2 percent of the developed campsites and 1.1 percent of the boat launches. The percent of picnic areas was not calculated, because Table 3.20-4 only includes day-use only picnic areas and does not include day-use areas that are also associated with overnight facilities. In addition, there are a multitude of other recreational facilities in the region; Table 3.20-1 lists public lands, but there are private facilities as well. Also, approximately two-thirds of recreational visitors to the Lower Klamath Project reservoirs had negative perceptions of water quality, stating concerns of bad odors and phytoplankton (e.g., blue-green algae) blooms, which restrict areas available for fishing, swimming, and wading (PacifiCorp 2004). Therefore, the loss of Iron Gate and Copco No.1 reservoirs under the Proposed Project would not result in a long-term loss in regional lake-based recreational activities that would affect a large area or a substantial number of people.

With respect to local recreational facilities and access points, the Proposed Project would completely remove most of the existing recreational sites at Iron Gate, Copco No. 1, and J.C. Boyle reservoirs, which primarily provide fishing, boating, and day-use access to the three reservoirs. Several existing recreational sites also provide camping facilities for overnight use. Decommissioning of these facilities would include removal of structures, concrete and pavement, regrading and revegetation of associated parking areas, access roads, and other improvements (Appendix B: *Definite Plan – Appendix Q*). Facilities at Fall Creek and Jenny Creek Day-Use Areas at Iron Gate Reservoir, Topsy Campground at J.C. Boyle Reservoir, and the Iron Gate Fish Hatchery Day-Use Area downstream of Iron Gate Reservoir, would remain, where possible, and be upgraded or enhanced (Appendix B: *Definite Plan – Appendix Q*). In addition, most existing river access facilities would be retained and upgraded.

The Proposed Project includes a Recreation Plan (see Appendix B: *Definite Plan – Appendix Q* for the Draft Recreation Plan) that would be used to identify new recreation opportunities that offset the proposed removal of reservoir recreation sites as well as the reduction in whitewater boating days resulting from the Proposed Project (see Potential Impact 3.20-5 for a discussion of whitewater boating). KRRC has started an ongoing stakeholder outreach process seeking input from potentially impacted recreation users, operators, managers and administrators, including tribes, state and federal agencies, county agencies and chambers of commerce, local residents, recreation businesses, and public interest groups. The stakeholder outreach process would continue through the development of the Final Recreation Plan, which is scheduled for completion by KRRC in June 2019. The Draft Recreation Plan includes potential recreation opportunities identified in the USBR (2012) Detailed Plan as well as those identified through recent stakeholder outreach efforts. The Draft Recreation Plan also outlines preliminary criteria for screening opportunities, including whether each recreation opportunity would: *"directly address the recreation impacts generated by the KHSA;"* and *"directly address or offset changes in the localized reservoir recreation or Hells Corner boating near where the impacts are occurring."* In addition, the Proposed Project includes the transfer of approximately 8,000 acres of real property (Parcel B lands; see also Section 2.7.10 *Land Disposition and Transfer*) located in Klamath County, Oregon, and Siskiyou County, California, to the respective states (or a designated third party) for public interest purposes, including river-based recreation, open space, active wetland and riverine restoration, and public education.

The Proposed Project would result in the loss of the locally popular fishery for non-native fishes including largemouth bass, trout, catfish, crappie, sunfish, and yellow perch (Hamilton et al. 2011). Fishing is popular in Copco No. 1 and Iron Gate reservoirs, especially for yellow perch, with one fishing guide (Shaffer 2005) considering the reservoirs the best yellow perch fishery in California. Without the Lower Klamath Project dams, fishing for non-native warm water species would be lost at the Lower Klamath Project reservoirs. While the yellow perch fishery in the reservoirs is considered by Shaffer (2005) to be the best in California, it does not constitute a unique recreational resource since there are other yellow perch fishing opportunities near the Copco No. 1 and Iron Gate reservoirs in northern California and southern Oregon, including Emigrant Lake (Ashland Daily Tidings 2009). Additionally, fishing tournaments like the largemouth bass tournaments (e.g., Rogue Valley Bassmasters) in Iron Gate Reservoir would no longer occur under the Proposed Project (Hamilton et al. 2011). However, yellow perch fishing and bass tournaments occur in dozens of lakes in northern California and southern Oregon, including some of those listed in Table 3.20-4, because these non-native fish occur over large areas of the Western United States. Thus, Copco No. 1 and Iron Gate reservoirs do not constitute a unique recreational resource with respect to perch, largemouth bass, and other warm water fishing. Steelhead, trout, and salmon fisheries would be enhanced by the Proposed Project, since Lower Klamath Project reservoir habitat would be replaced by riverine habitat that supports these cold water species. Lastly, the loss of warm-water fishing in Iron Gate and Copco No. 1 reservoirs does not represent the loss of a recreational resource that would affect a large number of people. Therefore, fishing-related impacts from the Proposed Project would be less than significant.

Given that a number of other lakes and reservoirs in the vicinity of the Lower Klamath Project provide similar opportunities for reservoir-based recreation in an uncrowded setting, KRRC's proposal to retain and enhance most existing river access facilities within the Area of Analysis for recreation, and Parcel B land transfer under the Proposed Project that would potentially allow for additional future river-based recreation opportunities, the Proposed Project would be highly unlikely to result in a loss of rare or unique recreational facilities affecting a large area or substantial number of people. In addition, the KRRC has prepared a Draft Recreation Plan (Appendix B: *Definite Plan – Appendix Q*) that includes stakeholder outreach, identification of potentially new or modified recreational facilities as well as evaluation and screening criteria, which will further reduce any potential impacts.

Significance

No significant impact

Potential Impact 3.20-3 Significant increase in the use of regional recreational facilities due to loss of Iron Gate and Copco No. 1 reservoirs, such that substantial physical deterioration or acceleration of deterioration of the regional facilities would occur.

The Proposed Project would result in the loss of reservoir-based recreational facilities at Iron Gate and Copco No. 1 reservoirs, but this impact is not significant for the reasons discussed in Potential Impact 3.20-2. While the Proposed Project also includes the creation of additional recreational facilities and opportunities, the types of river-based recreational opportunities available following dam removal activities, including camping in a river setting as opposed to camping in a lake/reservoir setting, may not appeal to the same recreational users who currently visit and recreate at Iron Gate and Copco No. 1 reservoirs. In other words, while new recreation opportunities would exist along the restored river corridor, there could be a change in user type.

A number of other lakes and reservoirs are in the vicinity of the Lower Klamath Project reservoirs and provide similar opportunities for recreation in an uncrowded setting for people specifically seeking lake or reservoir-based recreation (Table 3.20-4). Specifically, Fourmile Lake, Agency Lake, Applegate Reservoir, and Medicine Lake, are located from 26 to 46 miles away from Iron Gate and Copco No.1 reservoirs, and each exhibits generally low use-levels as well as similar or greater surface area, number of developed campsites, and number of improved boat launches. Within Klamath County and Jackson County, Oregon, and Siskiyou County, California, there are more than 85 boatable lakes, containing nearly 40 boat ramps (Boat Escape 2017). There are also more than 180 high-elevation and wilderness lakes in Siskiyou County (FERC 2007). In addition to boat ramps, these lakes provide nearly 2,300 developed campsites within less than a two-hour drive from Iron Gate and Copco No. 1 reservoirs (Table 3.20-4). The Lower Klamath Project reservoirs only account for less than 1.5 percent of the surface area of the regional lakes, 2.2 percent of the developed campsites and 1.1 percent of the boat launches. In addition, there are a multitude of other recreational facilities in the region; Table 3.20-1 lists public lands, but there are private facilities as well. Given the number and proximity of these regional lakes, as well as other lakes and reservoirs summarized in Table 3.20-1, the loss of Iron Gate and Copco No. 1 reservoirs under the Proposed Project would not be a significant impact because it would not result in a substantial increase in the use of regional lake and reservoir recreational facilities such that deterioration of those facilities would occur or be accelerated.

Significance

No significant impact

Potential Impact 3.20-4 Effects on the environment due to construction of new or expansion of existing recreational facilities.

As described previously, the Proposed Project involves the development and implementation of a plan to construct new recreational facilities and river access points along the restored river channel between the California-Oregon border and Iron Gate Dam following dam removal activities. Replacement of recreation facilities would not necessarily be "like for like", but rather would be designed to accommodate similar levels, if different types of use. This would require the creation of new gravel roads and other improvements for vehicle and visitor access to and use of the new river-based recreation sites, which could result in construction-related impacts to the environment, including potential impacts to water quality and historical and/or tribal cultural resources.

While new recreation facilities are part of the Proposed Project, the final location, size, and design of the facilities are still under development and will be the subject of subsequent approvals. It is thus too soon to conduct a meaningful environmental analysis of the replacement facilities. However, construction and operation of new recreational facilities would undergo any environmental review necessary for the subsequent approvals, and any impacts of the construction and operation of the facilities would be mitigated, if feasible, to levels that comply with all applicable laws, regulations, and environmental standards. Because this component of the Proposed Project would not be approved until a later date, for the purposes of this EIR the impacts of this component are not significant.

Significance

No significant impact

Potential Impact 3.20-5 Changes to or loss of river conditions that support whitewater boating.

Dam removal activities would not affect whitewater boating access locations, as access areas are at established places along the Klamath River channel, outside of the Lower Klamath Project reservoirs and would not be affected by dam removal activities. As discussed in the impact analysis above and in Potential Impact 3.11-6, drawdown of the reservoirs would not result in substantial changes to the floodplain or river channel. Thus, no impacts to land-based recreational facilities would be expected. Therefore, there would be no adverse impacts on whitewater boating access downstream of Iron Gate Dam. However, in the reaches between the existing dams, particularly in the Hell's Corner Reach, whitewater boating access would likely be temporarily affected due to dam removal activities and sedimentation, as discussed previously. However, these short-term impacts on whitewater boating access locations would be less than significant.

The average number of days providing acceptable river flows in specific reaches each month was modeled for specific recreational activities as part of the 2012 KHSA EIS/EIR under the KBRA Flows (see Appendix S). However, flow requirements in the Klamath River have changed since the modeling for the 2012 KHSA EIS/EIR was performed, with 2013 BiOp Flows replacing the KBRA Flows as detailed in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* and Appendix S.

Differences in the monthly flow ranges between the 2013 BiOp Flows and the KBRA Flows result in changes to the previously-modeled number of days with acceptable flows for whitewater boating during certain months. The greatest differences would occur during summer and fall in the Klamath River reaches between Keno and Iron Gate dams due to variations in the amount of time flows would be within the acceptable range for whitewater boating between the 2013 BiOp Flows and the KBRA Flows. Whitewater boating requires a minimum flow of 1,000 cfs to 1,300 cfs in the Keno, J.C. Boyle Bypass, and Hell's Corner reaches of the Klamath River. In July through September, KBRA Flows would exceed 1,000 cfs during wet water years, with KBRA Flows exceeding 1,300 cfs during wet water years in July. However, the 2013 BiOp Flows would remain below 1,000 cfs during all water year types between July through September, so the number of days whitewater boating could occur between July and September in the Keno, J.C. Boyle Bypass, and Hell's Corner reaches of the Klamath River would be zero under the 2013 BiOp Flows. Conversely, in October the average number of days of whitewater boating would increase under the 2013 BiOp Flows relative to the KBRA Flows since the 2013 BiOp Flows exceed 1,000 cfs in 30 percent of years, but the KBRA Flows are always below 1,000 cfs. Overall, the average number of days supporting whitewater boating for all water year types between Keno and Iron Gate dams would decrease under the 2013 BiOp Flows compared to under the KBRA Flows, since decreases in July through September are expected to be greater than an increase in October (see Appendix S for more detail). Downstream of Iron Gate Dam, the differences between the 2013 BiOp Flows and the KBRA Flows would not significantly alter the previously modeled average number of days whitewater boating could occur because the flow variations would occur within the range of acceptable flows for whitewater boating. Thus, the average annual number of days estimated by the previous modeling downstream of Iron Gate Dam is generally representative of trends and conditions under the 2013 BiOp Flows (see Appendix S for more detail).

Model results under the KBRA Flows indicate that the changes in the availability of flows within the acceptable flow ranges for whitewater boating and fishing opportunities would be negligible for the reaches downstream from Iron Gate Dam. As previously discussed, whitewater boating opportunities under the Proposed Project with 2013 BiOp Flows would be similar to model results under the KBRA Flows downstream of Iron Gate Dam. Dam removal activities would likely improve access and create new opportunities in the reservoir reaches, which would benefit whitewater boating opportunities in this area. Given negligible changes in flows and improvements in access, impacts in reaches downstream from Iron Gate Dam would not be significant.

The reaches of the Klamath River that are currently inundated by the existing Copco No. 1 and Iron Gate reservoirs would be converted to free-flowing riverine reaches over the long term, and depending on the river channel and access, could provide additional opportunities for whitewater boating in these reaches. However, river flows following dam removal activities were not modeled for areas currently inundated by reservoirs. While it could be expected there would be additional opportunities for whitewater boating in these reaches, no records exist of the condition or suitability of the presently inundated areas for whitewater boating activities. With details of the condition of these areas lacking, it is too speculative to determine the quality and quantity of whitewater boating opportunities that could be realized due to dam removal activities in areas currently inundated by reservoirs. Accordingly, this analysis does not rely on the creation of whitewater boating opportunities in these reaches.

In contrast, for the Copco No. 2 Bypass Reach, model results indicate there would be a substantial increase in whitewater boating opportunities during the July through September time period. Comparison of the monthly range of KBRA Flows utilized in the modeling with the 2013 BiOp Flows indicates that the whitewater boating opportunities during the July through September time period would still increase under 2013 BiOp Flows, but the magnitude of the increase may be more than modeled under the KBRA Flows for the 2012 KHSA EIS/EIR. The flows would be more likely to be within the range of acceptable flows for whitewater boating in the Copco No. 2 Bypass Reach (i.e., 600 cfs to 1,500 cfs) under 2013 BiOp Flows than the modeled KBRA Flows, especially during July (see Appendix S for more detail). The increase in the number of days with acceptable flows for whitewater boating would be a long-term beneficial effect on whitewater boating in the Copco No. 2 Bypass Reach.

In the J.C. Boyle Bypass Reach, modeling done in 2012 under the KBRA Flows show an increase in the average annual number of days with acceptable flows for whitewater boating during the July through September time period after implementation of the Proposed Project. Under the Proposed Project with 2013 BiOp Flows there would be no increase in the whitewater boating opportunities in the J.C. Boyle Bypass Reach. Similar to baseline conditions, Klamath River flow between July and September would remain below the minimum flow necessary for whitewater boating in this reach (i.e., 1,000 cfs) under the 2013 BiOp Flows, so the average annual number of days with acceptable flows for whitewater boating under the Proposed Project would be similar to the model results for the No Project scenario (see Appendix S for more detail). With the Proposed Project operating under the 2013 BiOp flow regime, there would be no impact on whitewater boating in the J.C. Boyle Bypass Reach.

The Hell's Corner Reach is located partially in California and partially in Oregon. This stretch of river would be impacted by removal of the J.C. Boyle Dam, which is part of the Proposed Project and is located in Oregon. Since potential impacts to flows in the Hell's Corner Reach were brought up as an issue during the Lower Klamath Project scoping process, and because the impacts would also occur in California, a discussion and analysis is included in this EIR. Currently, the Hell's Corner Reach is the only Class IV+ rapids in the region with late summer flows. Whitewater rafters can boat on the Hell's Corner Reach from April through October due to hydroelectric peaking power and flows historically generated by J.C. Boyle Powerhouse to meet high power demand periods. This typically occurs for four hours, between 10 a.m. and 2 p.m. each day. It also happens approximately 15 to 20 days per month in July, August and September. Additionally, flow peaking occurs on a predictable schedule, which is highly favorable for commercial boating operations. The vast majority of rafting is performed by permitted commercial outfitters, due to the technical difficulty of the run and lack of access to scouting points. There are 10 outfitters, which take up to 200 clients down the river per day, primarily between July and September, and BLM has set an overall carrying capacity of 250 people per day on this stretch of river (DOI 2011).

In the Hell's Corner Reach, there would be loss of acceptable flows for whitewater boating opportunities with the Proposed Project as compared to existing conditions. The minimum flow necessary for whitewater boating in this reach is estimated to be between 1,000 cfs and 1,300 cfs. Klamath River flow in the high demand months of July to September are expected to remain below 1,000 cfs under the 2013 BiOp Flows based on an evaluation of flow exceedance curves at Keno Dam. Flow accretion from groundwater springs may cause some increase in the flow between Keno Dam and the Hell's Corner Reach, but the flow exceedance curve at Keno Dam is still expected to be representative of flow conditions within the Hell's Corner Reach under the Proposed Project with 2013 BiOp Flows. Flow in the Hell's Corner Reach would be below the minimum flow necessary for whitewater boating between July and September, eliminating opportunities for whitewater boating during this time under the Proposed Project. For the month of October, some whitewater boating opportunities would exist during wetter years, with the Proposed Project operating under but there would be a significant reduction compared to existing (see Appendix S for more detail).

There are a number of alternative rafting opportunities in the region that are available all summer, including the Klamath River downstream of Iron Gate Dam, Trinity River and Rogue River. However, due to the lower late summer flows, the higher-class rapids are not available, typically from July until the fall rains start. From spring through early summer, there are ample whitewater rafting opportunities for all skill levels in the region (see Table 3.20-3). However, whitewater boating opportunities within the Hell's Corner Reach would be eliminated during July through September and significantly reduced in October.

The Proposed Project would result in the loss of a unique opportunity in the region to raft Class IV+ rapids for three months during the late summer and early fall. This would affect up to 250 people per day during that time, as well as 10 commercial outfitters. However, the resource is not lost completely due to the following: (1) alternative Class IV+ whitewater boating opportunities during other times of the year; and (2) ample alternative nearby rafting opportunities in the late summer, albeit with lower class ratings. However, the impact to whitewater boating opportunities in the Hell's Corner Reach (within the upper portion of the Hydroelectric Reach) would be significant and unavoidable.

Significance

No significant impact in the Middle and Lower Klamath River

Significant and unavoidable in the Hell's Corner Reach (within the upper portion of the Hydroelectric Reach)

Potential Impact 3.20-6 Changes to or loss of other river-based recreation including fishing.

No significant impacts to river-based recreational facilities upstream of the Hydroelectric Reach would occur as a result of the Proposed Project, because any changes to flow and water quality would occur within and downstream of this reach. However, as discussed in Potential Impact 3.3-7 through 3.3-11 in Section 3.3.5.9 *Aquatic Resource Impacts*, removal of the dams would help eliminate barriers to volitional fish passage in the Klamath River upstream of the Lower Klamath Project, which would beneficially affect recreational fishing at these upstream locations.

In general, river-based recreational facilities downstream of the Hydroelectric Reach would not be physically affected by dam removal activities, since there would be little change to the 100-year floodplain extent under the Proposed Project (see also Potential Impacts 3.6-3 and 3.20-1). However, along the Middle Klamath River from Iron Gate Dam (RM 193.1) to the confluence with Humbug Creek (RM 174.0), the 100-year floodplain extent would change slightly due to dam removal and this would potentially impact existing recreational facilities. At the Blue Heron RV Park, the Fish Hook Restaurant (see Site "FS-2" in Appendix B: *Definite Plan – Appendix C, Figure 7.7-1 Sheet 1*) is within the 100-year floodplain extent under current conditions and would remain within the (altered) 100-year floodplain extent following dam removals. The R Ranch office at the Klamath Campground (see Site "FS-3" in Appendix B: *Definite Plan – Appendix C, Figure 7.7-1 Sheet 2*) is also within the 100-year floodplain extent under current conditions and would remain within the (altered) 100-year floodplain extent following dam removals. Thus, there would be no change or loss to these facilities under the Proposed Project. The Blue Heron RV Park office structure (see Site "FS-1" in Appendix B: *Definite Plan – Appendix C, Figure 7.7-1 Sheet 1*) is not within the 100-year floodplain extent under current conditions and would be within the (altered) 100-year floodplain extent following dam removals. While there would be an increased potential for flooding at this office structure, this would not represent a change or loss of a rare or unique recreational facility affecting a large area or substantial number of people and therefore impacts to recreation would be less than significant. In addition, the Proposed Project includes implementation of the Downstream Flood Control Project Component, as described in Section 2.7.8.4 *Downstream Flood Control* and in Appendix B: *Definite Plan.* Thus, under the Proposed Project, KRRC would move or elevate legally-established structures, where feasible, to reduce the risks of exposing people and/or structures to damage, loss, injury, or death involving flooding, which would further reduce the potential for flooding impacts to this structure.

Downstream of Humbug Creek (RM 174.0), there would be no significant effect on flood elevations (Potential Impact 3.6-3) and therefore there would be no impacts to river-based recreational facilities, including to the Klamath National Forest Tree of Heave Campground near the confluence of Humbug Creek (Figure 7.7-1 in Appendix B: *Definite Plan – Appendix C*).

Over the long term, removal of the Lower Klamath Project dams is also expected to result in water quality improvements within the Hydroelectric Reach and in the Middle and Lower Klamath River downstream of Iron Gate Dam (see Potential Impacts 3.2-1, 3.2-11, 3.2-12, and 3.2-13), which could improve visitor perceptions and attract a greater number of visitors to existing recreational facilities.

Dam removal activities are expected to result in long-term improvements in water quality, notably by decreased prevalence of microcystin toxin during summer phytoplankton blooms in the Lower Klamath Project reservoirs and in the Middle and Lower Klamath River. As discussed in Section 3.2.2.7 *Chlorophyll-a and Algal Toxins* and Section 3.20.2.4 *Wild and Scenic River Conditions*, microcystin toxin has been associated with public health risks for recreational bathing waters. Health warnings issued in 2005, 2008, 2009, 2010, 2012, 2013, 2014, 2016, and 2017 by the USEPA, the North Coast Regional Board, and other agencies warned recreation visitors to use caution due to the potential health effects of contact with waters containing elevated microcystin concentrations. In addition, 91 percent of recreational survey respondents indicated that water quality detracted from their experience at least a little within the

Hell's Corner Reach (PacifiCorp 2004). These adverse effects related to water quality negatively influenced the quality of the recreational experience for visitors and also resulted in safety risks to the recreational visitors. As existing conditions for water-contact-based recreational activities are considered adverse due to water quality, improved water quality conditions would result in long-term beneficial effects.

As discussed in Section 3.3.5.9 *Aquatic Resource Impacts*, dam removal activities are anticipated to result in increased abundance of recreational fish species from increased access to suitable habitat, and improved habitat conditions. The increased fisheries populations and abundance would beneficially affect recreational fishing opportunities. More specifically, the increased abundance and extent would allow for enhanced fishing opportunities and could decrease the number of closures of entire fishing seasons over the long term. These effects on recreation-based fisheries would be long-term and beneficial.

The Proposed Project would improve river access and create new fishing opportunities in the Hydroelectric Reach through implementation of the Recreation Facilities Plan (see Potential Impact 3.20-2), which would benefit fishing opportunities in this area. Given negligible changes in flows and improvements in access, impacts in reaches downstream from Iron Gate Dam would be less than significant. There would be a slight reduction in length of time available for fishing in the Copco No. 2 Bypass Reach, which would primarily occur during May due to the availability of acceptable flows (Table 3.20-5). In the Hell's Corner Reach, there would be a reduction in the availability of acceptable flows during April; however, the impacts would be minor overall and outweighed by other beneficial effects (Figure 3.20-4).

Significance

No significant impact for the Middle Klamath River between Iron Gate Dam (RM 193.1) and Humbug Creek (RM 174.3)

Beneficial for the Hydroelectric Reach, the Middle Klamath River downstream of Humbug Creek (RM 174.3), and the Lower Klamath River

Potential Impact 3.20-7 Effects on Wild and Scenic River resources, designations, or eligibility for listing.

The following section provides an assessment of the effects of the Proposed Project on each of the four resources specified in the Wild and Scenic River Act Section 7(a) (i.e., scenery, recreation, fish, and wildlife river values). The evaluation criteria presented in Section 3.20.4.5 *Impact Analysis Approach* were used to assess the effects of the Proposed Project as compared with conditions present at the time of wild and scenic river designation or eligibility listing, as well as changes to the condition of the river since the time of the designation or eligibility listing that have affected its wild and scenic character.

Potential impacts to scenery on designated California Klamath Wild and Scenic River segment.

As previously discussed in Section 3.20.2.4 [*Recreation] Environmental Setting – Wild and Scenic River Conditions*, the historic scenic character of reaches downstream from Iron Gate Dam has been impacted by reduced water clarity and discoloration resulting from large seasonal phytoplankton blooms in the Lower Klamath Project reservoirs that are subsequently transported into the Middle and Lower Klamath River. The Proposed

Project would eliminate the major sources of seasonal phytoplankton blooms to the Klamath River downstream of Iron Gate Dam (see also Section 3.4.2.3 *[Phytoplankton and Periphyton] Hydroelectric Reach,* Section 3.4.2.4 *[Phytoplankton and Periphyton] Middle and Lower Klamath River,* and Potential Impact 3.4-2), enhancing water appearance in the wild and scenic river segment of the Klamath River in California by eliminating or substantially reducing seasonal algal surface scums in the Middle and Lower Klamath River and increasing water clarity during summer low-flow periods.

As discussed in Potential Impact 3.2-3, drawdown of the reservoirs would result in short-term increases in turbidity (also expressed as suspended sediment concentration [SSCs]) downstream from the Lower Klamath Project reservoirs. Elevated turbidity would be most pronounced immediately downstream from Iron Gate Dam to Bogus Creek and it would become less noticeable farther downstream due to dilution from tributary flows entering the Klamath River. Modeling of SSCs during drawdown indicates SSCs would decrease to 60 to 70 percent of the initial value by Seiad Valley (RM 132.7) and to 40 percent of the initial value downstream of Orleans (approximately RM 59). Sediment jetting would occur during drawdown maximize erosion of accumulated sediments during this period and potentially reduce turbidity after drawdown concludes, and immediate revegetation would occur to further minimize the potential for prolonged increases in turbidity. Turbidity in the Klamath River is anticipated to flush through the system relatively quickly, but based on modeling of SSCs elevated turbidity is conservatively anticipated to occur for six to ten months following drawdown, with turbidity completely resuming natural background levels by the end of post-dam removal year 1 regardless of the water year type (USBR 2012a) (see Potential Impact 3.2-3 for more details). Although removal of the dams would result in increases in SSCs (Potential Impact 3.2-3) and decreased water clarity, the SSC increases would be short term and as such would not affect scenic value such that the long-term wild and scenic river designation or eligibility for listing would be compromised. In the long term, improved water appearance from on-river, in-river, and/or riverside viewpoints would improve the wild and scenic character of the Klamath River below the Lower Klamath Project.

With respect to periphyton colonization in the California Klamath wild and scenic river segment, although increased nutrient transport and recycling following dam removal could favor enhanced periphyton growth downstream from Iron Gate Dam, dam removal would also restore more frequent river sediment movement (Potential Impact 3.11-6) and increased flow variability during storm flow downstream of Iron Gate Dam, which could result in increased scouring of periphyton during late spring storm events (Potential Impact 3.4-5). The magnitude of the effect of bed turnover and scouring on periphyton would decrease with distance downstream, with increased scour occurring from Iron Gate Dam to approximately the Shasta River (RM 179.5), or the upper portion of the California Klamath River wild and scenic river segment. Information about water appearance at the time of California Klamath River wild and scenic river designation is sparse; however, it is likely that the existing trend of increasing periphyton blooms with their associated water coloration, cloudiness, and limitations on depth of view was already underway at the time of wild and scenic river designation (Van De Water et al. 2006). Although there would be negative water clarity impacts on scenic quality due to elevated SSCs during reservoir drawdown, the increases would be temporary and as such would not affect scenic value in a manner that would compromise the long-term wild and scenic river designation or eligibility for listing. Instead, the long-term effect of the Proposed Project would improve the scenic value of the California Klamath River wild and scenic river segment.

As discussed in Section 3.3.5.9 *Aquatic Resource Impacts*, removal of the Lower Klamath Project dams is expected to increase the long-term abundance, productivity, population spatial structure, and genetic diversity of fall-run Chinook salmon (Potential Impact 3.3-7), spring-run Chinook salmon (Potential Impact 3.3-8), coho salmon (Potential Impact 3.3-9), steelhead (Potential Impact 3.3-10) and Pacific Lamprey (Potential Impact 3.3-11) in the Klamath River. The expected restoration of the anadromous fish populations would largely be the result of the increased access to anadromous fish habitat within the Upper Klamath Basin, along with water quality improvements downstream from the Lower Klamath Project. The increased population of fish species and increased water clarity would improve scenic fish viewing value. Increased fish viewing would be most prominent during fish migration, spawning, or holding periods, when the fish concentrate at particular reaches, pools, riffles, and falls. Fish and wildlife viewing impacts to scenic quality would be long-term and beneficial for the California Klamath River wild and scenic river segment.

Specific effects on river-dependent wildlife populations and scenic viewing opportunities are unknown. As discussed in Section 3.5.5.5 [*Terrestrial Resources] Potential Impacts and Mitigation – Wildlife Corridors and Habitat Connectivity*, riparian habitat in the Iron Gate Dam to Shasta River reach of the California Klamath River wild and scenic river segment would potentially be improved by dam removal activities because proportional increases in wildlife presence related to the increase in abundance of anadromous fish in the river and scenic wildlife viewing are expected. Therefore, effects on river-dependent wildlife populations and scenic viewing opportunities would be long-term and beneficial.

Removal of the Lower Klamath Project may result in an increase in riparian vegetation immediately downstream from Iron Gate Dam due to more regular transport of riverbed sediments (Potential Impact 3.11-5) and sediment deposition that has the potential to create new surfaces for riparian plants to colonize (Potential Impact 3.5-5). Improved riparian vegetation would increase the presence and scenic variety of the vegetation within the Klamath River wild and scenic river segment in California. This would likely increase overall scenic riparian vegetation aspects of scenic quality over conditions present at the California Klamath River wild and scenic river segment's 1981 date of designation, as updated by existing conditions, and result in long-term beneficial effects.

The California Klamath River wild and scenic river segment is downstream from the Lower Klamath Project; therefore, removal of the dams and associated facilities would not result in any changes to the overall landscape character in the designated segment of the river. However, as discussed above, water appearance in the wild and scenic river segment is expected to improve due to elimination or reduction of large seasonal phytoplankton blooms transported into the Middle and Lower Klamath River (Potential Impact 3.4-2), as is the quality of the riparian vegetation (Potential Impact 3.5-4). These improvements would result in a more natural landscape character for the California Klamath River wild and scenic river segment and result in a long-term positive scenic quality effect from both near river and distant viewpoints.

Potential impacts to recreation on designated California Klamath Wild and Scenic River segment.

During dam removal years 1 and 2, release of sediment deposits stored within the reservoir footprints could decrease the quality of and opportunity for water contact activities. However, initial reservoir drawdown would occur in the coldest high flow months of winter and early spring when recreation use of the Lower Klamath Project reservoirs is at its lowest. Further, the increases in SSCs (Potential Impact 3.2-3) and decreased water clarity during dam removal would be short term so these would not affect the scenic value in a manner that would compromise the long-term wild and scenic river designation or eligibility for listing. In the long term, dam removal activities would improve water quality and also improve water contact-based recreation activities. For the California Klamath River wild and scenic river segment, dam removal activities would not affect recreational activities access downstream from the dams, and dam removal activities would result in improved water quality downstream from the dams in the long term; thus, there would be long-term beneficial effects on recreational activities in these areas as compared to the 1981 conditions and existing conditions.

Whitewater boating opportunities relating to river flow following removal of the Lower Klamath Project would likely be similar to 1981 conditions and current conditions of the California Klamath River wild and scenic river segment. As discussed in Potential Impact 3.20-5, following removal of the dams, changes in the availability of flows within the acceptable flow ranges for whitewater boating and fishing opportunities would be negligible for the reaches downstream from Iron Gate Dam following dam removal. Whitewater boating opportunities under the Proposed Project with 2013 BiOp Flows would be similar to results previously modeled under the KBRA Flows downstream of Iron Gate Dam. Therefore, no adverse impacts to flow-related whitewater boating opportunities would occur for the California Klamath River wild and scenic river segment. Dam removal activities would also result in long-term improvements to water quality conditions over existing conditions and the 1981 conditions. With improved water quality, the whitewater boating recreation experience would also improve. Therefore, long-term water quality-related whitewater boating impacts would be beneficial for the California Klamath River wild and scenic river segment.

As discussed in Potential Impact 3.20-6, removal of the Lower Klamath Project would not result in substantial increases or decreases in the number of days with acceptable flows for recreational fishing. However, as described in Potential Impacts 3.3-7 through 3.3-11, the geographic extent of the Klamath River fish habitat would be substantially expanded compared to 1981 and existing conditions. Moreover, the long-term improvements to water quality conditions are expected to reduce fish disease and increase the likelihood of fish survival. Increased fish populations could result in expansion of fishing seasons or increases to quotas and bag limits. Thus, recreational fishing effects from implementing the Proposed Project would be long-term and beneficial for the California Klamath River wild and scenic river segment.

There could be short-term impacts to recreational fishing during Lower Klamath Project reservoir drawdown. While it is not possible to accurately predict short-term deposition patterns in the mainstem Klamath River channel at a fine spatial scale (e.g., individual pools or other slack-water areas that may serve as fishing holes), general sediment transport and depositional patterns observed in the Klamath River and other analogous river channels indicate that dam-released sediment that may temporarily deposit in pools and other slack water areas (e.g., eddies) and at tributary confluences in the reach from

Iron Gate Dam to Cottonwood Creek would be highly erodible during subsequent flow events, leading to a short residence time (i.e., likely one year or less except during dry years) (Potential Impact 3.11-5). Thus, the potential for clogged fishing holes or less accessible shorelines that are temporarily blocked by sediment deposits of limited extent would be short-term and as such would not affect recreational value in a manner that would compromise the long-term wild and scenic river designation or eligibility for listing.

Further, In the short term, new beaches and riparian areas may become established, increasing the variety of shoreline settings. Most of these effects would be temporary and many aspects of the wild and scenic river segment's recreation setting would be considerably improved in the long term once the Klamath River stabilizes. The improved water quality conditions following completion of drawdown activities would improve the recreational setting overall (i.e., with improved clarity during swimming and fishing and reduced malodors and tastes [Bartholow et al 2005]). With regard to public health, improved water quality, and in particular a reduction in the potential for seasonal exposure to high levels of algal toxins (greater than 8 µg/L microcystin) generated by nuisance blooms in the Lower Klamath Project reservoirs and transported into the Middle and Lower Klamath River (Potential Impact 3.2-12) would also reduce potential human health risks associated with water-contact-based activities. Therefore, effects on the recreational setting would be long term and beneficial for the California Klamath River wild and scenic river segment.

Potential impacts to fisheries on designated California Klamath Wild and Scenic River segment.

Changes in flow regimes can affect fishery resources. Section 3.6.2.1 [*Flood Hydrology] Environmental Setting* discusses historic flow rates and discharge statistics for each of the reservoirs. The proposed drawdown rates for the Lower Klamath Project reservoirs are consistent with the historic discharge rates from the reservoirs and would be adjusted depending on the water year; therefore, flow rates downstream from the dams are not anticipated to increase substantially above historic rates, if at all. As such, conditions during the reservoir drawdown period (i.e., dam removal years 1 and 2) are expected to remain largely unchanged as compared to stream flow regimes at the time of the 1981 wild and scenic river segment designation.

Following removal of the Lower Klamath Project, the Klamath River would return to a natural flow regime in the Middle Klamath River immediately downstream of Iron Gate Dam. Restoration of the natural flow regime and upstream sediment supply would improve water quality conditions, likely reducing the occurrence of myxozoan parasites (*Ceratomyxa shasta* and *Parvicapsula minibicornis*) that are known to negatively affect salmonids. Increased spawning gravel from upstream sources could enhance spawning habitat following dam removal. Restoring natural sediment mobility processes could also help scour periphyton (e.g., *Cladophera* spp.) (Potential Impact 3.4-5), and deposited sand and gravel would be a less favorable substrate for the periphyton because of greater particle mobility during high-flow events than the existing armored substrate. A reduction in periphyton would reduce the habitat for the fish pathogen's alternate host (Section 3.3.5.5 *Fish Disease and Parasites*). Further, as discussed above, removal of the reservoirs would eliminate habitat for populations of blue-green algae that produce toxins that can result in acute and chronic effects on fish, including increased mortality, reduced fecundity, reduced feeding, and habitat avoidance (see Section 3.3.5.7 *Algal Toxins*). Thus, stream flow regime effects would be long term and beneficial for the California Klamath River wild and scenic river segment.

Removal of the Lower Klamath Project would improve water quality conditions over existing conditions and the 1981 conditions. As described in 3.2.5.1 *[Water Quality] Water Temperature* and 3.3.5.4 *[Aquatic Resources] Water Temperature*, following dam removal, the seasonal temperature regime downstream from Iron Gate Dam would be more suitable for salmon. As part of its relicensing procedure, PacifiCorp modeled changes in water temperature that could result following removal of the Lower Klamath Project dams. The modeling results show that from Iron Gate Dam to Clear Creek, water temperatures in the spring and early summer would be as much as 5°C warmer, but they would be cooler in later summer and fall than under existing conditions. Water temperatures currently remain greater than 20°C in dry years with little variability in July and August. Although summer temperatures would likely be more variable following dam removal, the median temperatures would be substantially lower than current conditions. Summer and fall water temperatures would therefore be more conducive to salmon rearing, migrating, and spawning than the conditions that likely existed in 1981 (Van de Water et al. 2006). Water temperature effects of dam removal would therefore be long-term and beneficial for the California Klamath River wild and scenic river segment.

Information about habitat conditions at the time of wild and scenic river segment designation is sparse; however, it is likely that existing trends of river coarsening, increasing habitat for periphyton, and reduced recruitment and maintenance of riparian vegetation were already underway at the time of wild and scenic river segment designation due to PacifiCorp facilities and operations. The Proposed Project would reduce those trends in the long term, and restore natural sediment transport processes, which were no longer in place by 1981. Following the initial drawdown period and flushing of reservoir sediment downstream, aquatic habitat conditions would be expected to improve compared with conditions in 1981, as well as existing conditions, in the long term. Therefore, effects on aquatic habitat conditions would be long-term and beneficial for the California Klamath River wild and scenic river segment.

As discussed in as described in Potential Impacts 3.3-7 through 3.3-11, dam removal would result in beneficial long-term effects on anadromous salmonids. Dam removal would restore connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin and would create additional spawning and rearing habitat within the Hydroelectric Reach. While, sediment released during dam removal could be sufficient to cause substantial smothering of spawning gravels, pool infilling, gill abrasion, and changes to holding and migration patterns in the Klamath River reaches immediately downstream of Iron Gate Dam, these impacts would be temporary, as sediment is expected to be flushed through the river system relatively quickly, and would not affect survivability of fish species in a manner that would compromise the long-term wild and scenic river designation or eligibility for listing. Removal of the Lower Klamath Project would also eliminate fish barriers and expand fish access to upstream spawning areas.

As discussed in Section 3.3.5.8 *Aquatic Habitat*, removal of the Lower Klamath Project would improve conditions for native resident fish species, including culturally important fish species (e.g., Chinook salmon, coho salmon, steelhead, and lamprey), by restoring connectivity between the Lower and Upper Klamath River, and by returning a natural flow regime to the reaches where the reservoirs currently exist, thereby improving water quality. Dam removal would also likely result in diminished non-native fish habitat and populations, reducing competition for space and resources with native resident fish (see

Potential Impact 3.3-17). Therefore, effects on the conditions for native resident fish species, including species traditionally used and culturally important to Indian Tribes, would be beneficial and long term in the California Klamath River wild and scenic river segment.

Potential impacts to wildlife on designated California Klamath River Wild and Scenic River segment.
Riparian vegetation in the California Klamath River wild and scenic river segment downstream from the Iron Gate Dam would benefit from dam removal activities In the long term, especially in the reach between the Iron Gate Dam and the Shasta River confluence (Potential Impact 3.5-4). Special status species that utilize riparian habitat, such as the willow flycatcher (Potential Impact 3.5-12) and Western pond turtle (Potential Impact 3.5-16) would benefit in the long term from successful riparian habitat recovery from Iron Gate Dam downstream to the Klamath River's confluence with the Shasta River.

In addition to improving riparian habitat, the Proposed Project would result in improvements in fish resources in the long term following dam removal, thus providing increased forage for wildlife species that depend upon fish as a food source. The area currently blocked by dams would provide additional available habitat for anadromous fish (see above discussion). Increased fish abundance would also create greater foraging opportunities for riparian and riverine species such as bald eagle, river otter, osprey and black bear (see also Potential Impact 3.5-24). Therefore, there would be a long-term, beneficial effect on habitat for special status species in the California Klamath River wild and scenic river segment. Because wildlife viewing is an important component of recreational opportunities within the Area of Analysis, impacts to recreation would also be long-term and beneficial.

Potential impacts to eligible and suitable California Wild and Scenic River section.
In addition to the designated wild and scenic river segment, the Klamath River reach from the California-Oregon state line to the upstream end of Copco No. 1 Reservoir was found to be "eligible and suitable" for wild and scenic river designation, though it has not yet been designated into either the National or the State Wild and Scenic River System. The potential outstandingly remarkable values include scenic, fish, wildlife, recreation (whitewater boating and fishing), and historic. This candidate wild and scenic river reach is included in the Area of Analysis for recreation.

Short-term negative impacts on water quality, scenic, recreation, fishery, and wildlife river values would be likely to occur due to high SSCs anticipated during drawdown of the upstream J.C. Boyle Reservoir (see Potential Impact 3.2-3). Short-term impacts would also occur as a result of restricted access and use of river-based recreation facilities and opportunities within the Limits of Work during dam removal years 1 and 2. However, these temporary impacts would not affect river values in a manner that would compromise the long-term wild and scenic river eligibility for listing. In the long term, dam removal under the Proposed Project would eliminate hydropower peaking and return this section of the Hydroelectric Reach to a more natural condition than under existing conditions. Overall, dam removal activities under the proposed Project that return this section of the Hydroelectric Reach to a more natural condition would result in long-term beneficial effects to this candidate wild and scenic river reach's free-flowing condition, water quality, scenic, wildlife, fishery, and recreation river values and the long-term wild and scenic river designation or eligibility for listing would be not be compromised.

Significance

No significant impact in the short term for the designated California Klamath River wild and scenic river segment.

No significant impact in the short term for the eligible and suitable California Klamath River wild and scenic river section

Beneficial in the long term for the designated California Klamath River wild and scenic river segment.

Beneficial in the long term for the eligible and suitable California Klamath River wild and scenic river section

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3.21 Hazards and Hazardous Materials

This section describes the environmental setting for hazards and hazardous materials, as well as potential environmental impacts and associated mitigation measures for the Proposed Project. The discussions in the following subsections focus primarily on the transport, use, and disposal of hazardous materials, school proximity to hazardous materials, contaminants and contaminated sites, nearby airports, emergency response plans, and wildfires.

The State Water Board received comments expressing the following concerns related to hazards and hazardous materials: water in the Lower Klamath Project reservoirs would no longer be available for use in fire suppression; and construction-related traffic, including hauling of hazardous materials and waste, would occur on the single access route for the Copco No. 1 Dam area, which could affect the safety of other road users such as school busses, residents, pedestrians, livestock and dogs. Additional details regarding the public comments received during the NOP public scoping process can be found in Appendix A.

3.21.1 Area of Analysis

The Area of Analysis for hazards and hazardous materials includes lands within the Project Boundary (Figure 2.2-4). This area includes the area in the immediate vicinity of Copco No. 1, Copco No. 2, and Iron Gate dams and reservoirs, and areas identified as construction/demolition and staging areas. The construction/demolition and staging areas are described in specific detail in this EIR in Section 2 *Proposed Project* and in Sections 5.3, 5.4, and 5.5 of Appendix B: *Definite Plan*. Consideration of hazards and hazardous materials also includes considering routes proposed to be utilized for the transportation of construction debris (see Section 3.22 *Traffic and Transportation*).

3.21.2 Environmental Setting

This section describes the environmental setting associated with the exposure to various potential hazards and hazardous materials. For discussion of other related hazards, the table below describes topics and where these other hazards are discussed.

Table 3.21-1. Hazards-related Discussion Found Elsewhere in this EIR.

Hazard	Section No.	Topic(s)
Water Quality	3.2	Water Quality
Flooding	3.6	Flood Hydrology
Vehicle and Toxic Emissions	3.9	Air Quality
Geologic	3.11	Geology and Soils
Emergency Response	3.17	Public Services
Emergency Response	3.22	Transportation and Traffic

3.21.2.1 Transport/Releases of Hazardous Materials

California Health and Safety Code Section 25501(n) defines hazardous material as any material "that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment."

Hazardous substances include, but are not limited to, hazardous materials, hazardous waste, and, any material which a handler or regulatory agency has a reasonable basis for believing would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.

California Code of Regulations (CCR), Title 22, Division 4.5, Chapter 11, Article 2, Section 66261.10, identifies a hazardous material as a substance (or combination of substances) that may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating illness, or that may pose a substantial hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Hazardous wastes are hazardous substances that no longer have practical use, such as materials that have been discarded, discharged, spilled, or contaminated, or are being stored until they can be disposed of properly. The Department of Toxic Substances Control (DTSC) (DTSC 2018a) further defines hazardous wastes as wastes from manufacturing processes, manufacturing industries, unused commercial chemical products or products containing mercury (CCR, Title 22, Division 4.5, Chapter 11, Article 4, Section 66261.31-33). Hazardous wastes can also be characterized as defined in Article 3 of Chapter 11 of the hazardous waste regulations (CCR, Title 22, Chapter 11, Article 3, §§ 66261.21–66261.24) according to four properties:

- toxicity (or the degree to which a substance can damage an organism),
- ignitability (or the capability of a material to be ignited or set on fire),
- corrosiveness (the ability of a material to eat away or disintegrate another material), and
- reactivity (the stability of a material).

The Hazardous Waste and Substances Sites List, also known as the Cortese List, is a planning document used by the state, local agencies, and developers to comply with CEQA requirements in providing information about the location of hazardous materials release sites. Government Code section 65962.5 requires the California Environmental Protection Agency (CalEPA) to maintain an updated Cortese List. DTSC is responsible for a portion of the information contained in the Cortese List. Other state and local government agencies are required to provide additional hazardous material release information for the Cortese List. Below are the data resources that provide information regarding the facilities or sites identified as meeting the Cortese List requirements (CalEPA 2017).

- List of Hazardous Waste and Substances sites from DTSC EnviroStor database.
- List of Leaking Underground Storage Tank Sites by county and fiscal year from State Water Board GeoTracker database.
- List of solid waste disposal sites identified by State Water Board with waste constituents above hazardous waste levels outside the waste management unit.
- List of Active Cease and Desist Orders and Cleanup and Abatement Orders identified by the Regional Water Quality Control Boards.
- List of hazardous waste facilities subject to corrective action pursuant to section 25187.5 of the Health and Safety Code, identified by DTSC.

Hazardous wastes that are to be transported off site would utilize local roads to reach Interstate 5 so that they can be disposed of at required facilities (see 3.22 Traffic and

Transportation for additional information). Likewise sources of hazardous materials, such as fuels and lubricants, welding materials, and explosives to be used during construction activities, will travel primarily from Interstate 5 along local roads to the work areas. This transport of materials could result in the potential for an increased risk in release of these hazardous substances into the environment.

There is an existing transfer station near the City of Yreka that accepts Class II sanitary landfill materials such as construction and demolition wastes, mixed municipal wastes, metals, and mixed municipal recyclable materials. Wastes are currently hauled 45 miles to the Dry Creek Landfill in White City Oregon. The Class I Anderson Landfill in Anderson, California, located 122 miles from Hornbrook, California, is permitted to accept hazardous waste, including treated wood waste. Existing capacity is available for wastes generated by the Proposed Project, as described in Section 3.18.2.4 *Solid Waste*.

USEPA is the primary federal agency responsible for the implementation and enforcement of hazardous materials regulations. In most cases, enforcement of the federal laws and regulations is delegated to state and local environmental regulatory agencies. California implements federal regulations through the DTSC, which identifies the Siskiyou County Environmental Health Department as the Certified Unified Program Agency. The Certified Unified Program Agency works closely with lead agencies through project review to ascertain the impacts from hazardous materials.

3.21.2.2 School Proximity

No schools are within a quarter mile of the dam demolition or equipment staging areas (see Figure 3.21-1). The closest existing schools to Iron Gate Dam are Bogus Elementary School, 5.4 miles away; Willow Creek Elementary School, 5.5 miles away; and Hornbrook Elementary School, 6 miles away. Distances from Copco No. 1 and Copco No. 2 to the nearest schools are similar to or greater than distances from Iron Gate Dam.

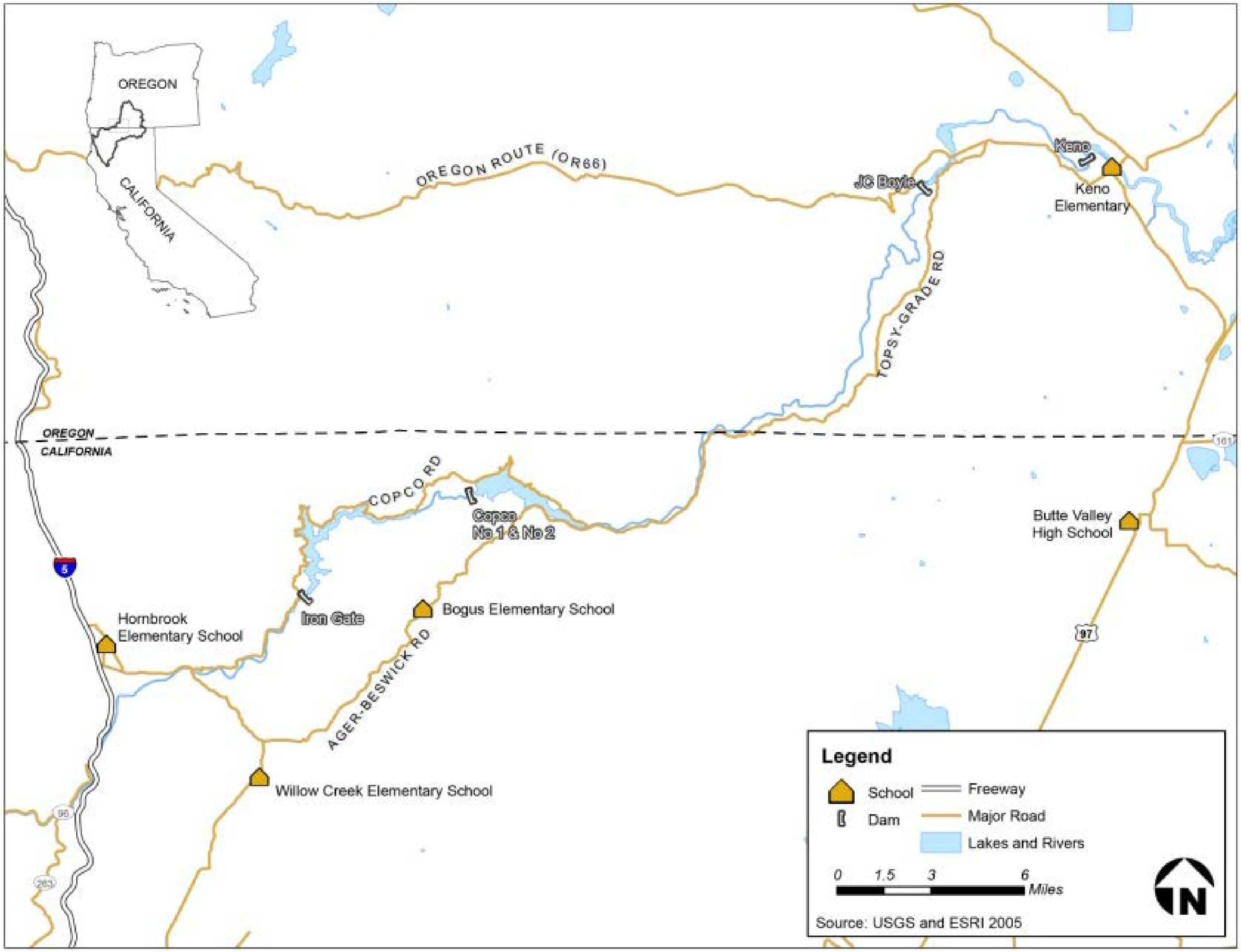

Figure 3.21-1. School Sites Near the Project Area.

3.21.2.3 Contaminants/Contaminated Sites

A comprehensive search of commercial databases was performed by Environmental Data Sources, Inc. (EDR 2010) to identify potential sites that may be contaminated with hazardous substances in the vicinity of the Proposed Project and to identify sites where soil and/or groundwater contamination may be present. Four Hazardous, Toxic, and Radioactive Waste (HTRW) sites, within the 2012 KHSA EIS/EIR Area of Analysis for hazards and hazardous materials, were identified by the 2010 EDR search. Two of the listings indicated the presence of underground and aboveground storage tanks at the Copco Lake Store and the "Pacific Power – Iron Gate," respectively; but there was no evidence of spills. The third listing referenced health limit exceedances in water samples from the Copco Lake Municipal Water Company for radium-228, arsenic (total), bromodichloromethane, dichloroacetic acid, and total haloacetic acids between 2004 and 2006, and for aluminum in water samples collected since 2004. The fourth listing resulted from a minor spill of non-PCB transformer oil at the Copco No. 2 Powerhouse, which was remediated and no longer is a site of concern. The spill is also listed in the California Hazardous Material Incident Reporting System and the Emergency Response Notification System databases. The EDR listing indicated that a bushing failed in 1999 at a transformer adjacent to the Klamath River releasing transformer oil. Most of the oil was contained, and less than one quart reached the Klamath River.

In addition to the four sites described above, the EDR research identified 162 "orphan sites," which are those sites that could not be mapped or "geocoded" due to inadequate address information along the two corridors of the Klamath River. Seven of the orphan sites are identified within the 2012 KHSA EIS/EIR Area of Analysis: Two are National Pollutant Discharge Elimination System-permitted facilities and one is a Waste Discharge Requirements-regulated facility; these do not present concerns related to HTRW. Two sites indicated the presence of underground and aboveground storage tanks at Iron Gate Dam; one site, listed on the Emergency Response Notification System, is the Copco No. 2 Powerhouse minor spill described above; and the remaining two sites were listed on the California Facility and Manifest Database and the leaking underground storage tank databases. No additional information was available in the State Water Board's GeoTracker database or the DTSC's EnviroStor database. No additional information on the presence of HTRW at the Proposed Project site is available.

An updated search of DTSC's Cortese List and search for sites with reported hazardous material spills, leaks, ongoing investigations, and/or remediation near the Proposed Project vicinity was performed using EnviroStor and GeoTracker (DTSC 2018b, State Water Board 2018). The updated search of site listings within these databases identified the Laubacher Ranch (Ager-Beswick Road, Montague, CA) as a leaking underground gasoline storage tank cleanup site undergoing remediation. The site is located adjacent to the Klamath River approximately four miles upstream from Copco No. 1 Reservoir. This case was completed/closed as of September 2017. (DTSC 2018b).

A review of the California Office of Emergency Services (CalOES) hazardous spill database was also reviewed for any incidents in the vicinity of the project facilities and the results are summarized in Table 3.21-2. (CalOES 2017). None of these indicated a need for further reporting.

Table 3.21-2. Hazardous Materials Spill Report.

CalOES 2018	Accessed 10/17/2018	Substance Type	Date
Control #	Reporting Party		
06-2856	PacifiCorp	Non-PCB Transformer Oil	5/12/2006
06-2940	NRC	Oil sheen in Klamath River	5/16/2006
12-4295	PacifiCorp	Oil from ski boat sank in Iron Gate Reservoir	7/24/2012
12-7480	Private Citizen	Septic sewage into creek. 20738 Ager Beswick Rd	12/7/2012
16-1355	PacifiCorp	Oil from vehicle crash into Iron Gate Reservoir.	3/4/2016
16-1563	Private Citizen	Diesel from leaking tractor. 15629 Klamath Rd	3/12/2016
17-1030	PacifiCorp	Oil from vehicle rolled into Iron Gate Reservoir	2/3/2017
17-2111	CALFIRE Yreka	Oil from boat fire	3/14/2017
18-1265	PacifiCorp	Oil from equipment spill, Fall Creek Rec Boat Ramp	2/26/2018

As reported in the 2012 KHSA EIS/EIR:

- In 2009, at the Copco No. 1 warehouse, soil known to be contaminated by petroleum products was removed from a former lube rack area. The final report and site cleanup was approved by a letter from Siskiyou County in 2010.
- In 2009, a former landfill site at Copco No. 2 Dam was removed per Siskiyou County review and approval.
- Copco No. 2 Dam's fueling facility has two aboveground storage tanks (1,000-gallon gasoline and 500-gallon diesel). No known spills or cleanups occurred at this facility.

No additional information was found related to these hazardous material issues at Copco No. 1 and No. 2 dams during the updated database searches (DTSC 2018b, State Water Board 2018).

The Lower Klamath Project dams and associated facilities include painted structures, equipment, and metalwork that may contain potentially hazardous materials. Window caulking, electrical wiring and components, building materials, and some coatings may contain asbestos. Surrounding soils may contain heavy metal contaminants where coatings have flaked off of the painted structures, equipment, and metalwork. There are no known reports that indicate building components and/or soil surrounding the facilities have been tested (Appendix B: Detailed Plan).

Certain closed systems, such as transformer bushings, cannot be tested until time of disposal. Thus, small quantities of polychlorinated biphenyls (PCBs) may be present in hydraulic fluids, soils, and in transformers and other electrical equipment, including older fluorescent light fixtures. Old light switches may contain mercury. The dams and hydroelectric facilities within the Proposed Project area may also include items such as transformers, batteries, bushings, oil storage tanks, bearing and hydraulic control system oils, lead bearings, soils or other material contaminated with lead from the use of lead-based paints or plumbing and 700 tons of creosote-treated wood in the wooden stave penstock at Copco No. 2 Dam (see also Appendix B: *Definite Plan – Appendix O3*).

Phase 1 and Phase 2 Environmental Site Assessments are currently underway (Appendix B: *Definite Plan*).

3.21.2.4 Nearby Airports

The Proposed Project is not located in the vicinity of any private or public use airport or airfield. Siskiyou County operates five public use, general aviation airports: Butte Valley, Happy Camp, Scott Valley, Weed, and Siskiyou County. A private emergency medic flight service operates between Medford, Oregon and Redding, California. Each airport is owned and operated by their respective city. The Siskiyou County Airport, located in Shasta Valley—11 miles east of Yreka—is home to a USDA Forest Service Fire Attack Base in the summer months (Greendot 2016). The USDA Forest Service also operates Happy Camp Airport at Happy Camp. The closest public airport to project facilities is Siskiyou County Airport, which is more than 10 miles south of Iron Gate Dam in Montague. Pinehurst State Airport in Oregon is located approximately nine miles north of Copco No. 1 Reservoir. The closest commercial airport in California to the proposed project is Redding Municipal Airport, located in Redding, approximately 130 miles south of the project site.

In addition to public use airports, a number of private airstrips are operated in Siskiyou County. Six private airstrips are listed for the area: Lefko, Round Mountain, Coonrod Ranch, Triple Ranch, McCloud, and Longbell Ranch. The closest private airstrip to the Proposed Project is Coonrod Ranch Airstrip, located approximately 25 miles south.

3.21.2.5 Emergency Response Plans

The Governor's Office of Emergency Services (CalOES) coordinates preparedness for and response to natural disasters such as earthquakes, fires, and floods by activating the California Standardized Emergency Management System (SEMS) used by all California public safety agencies. Section 3.17 *Public Services* contains a description of the various agencies (fire, police, medical) that would respond in case of an emergency within the Area of Analysis. Each of these agencies has their own defined emergency response capabilities. Developing an emergency response plan would be one of the elements required by SEMS.

Siskiyou County began the emergency response planning process in the 2010 Siskiyou County Multi-Jurisdictional Hazard Mitigation Plan (Plan). The Plan identified natural hazards within Siskiyou County and outlined the history, future vulnerability, and future damage potential for each hazard. The Plan's goal is to identify mitigation projects that will reduce the vulnerability and damage potential of each hazard. The Plan addresses earthquake, flood, wildfire, landslide/other earth movement, drought, severe weather/storm, dam failure, and volcano/lahar/ash fall hazards. For additional information visit http://www.co.siskiyou.ca.us/content/oes-hazard-mitigation-plan (accessed April 10, 2018).

As part of the County's plans for emergency evacuation, Siskiyou County has instituted a rapid emergency notification service called CodeRED®. CodeRED® employs internet mapping capability for geographic targeting of calls, coupled with a high-speed telephone calling system capable of delivering customized pre-recorded emergency messages directly to homes and businesses, live individuals, and answering machines. This service can be used in case of fires, chemical spills, evacuations, lock downs, downed power lines, lost individuals, natural disasters, abductions, water system problems, bomb threats, or other emergencies (County of Siskiyou 2018b).

No hospitals and only one fire station (Copco Lake Fire Department Station 210) at Copco No. 1 Reservoir, are within the Area of Analysis. The nearest hospitals are Fairchild Medical Center in the City of Yreka, California (18 miles southwest of Iron Gate Dam), Ashland Community Hospital in Ashland, Oregon (35 miles north-northwest of Iron Gate Dam), and Sky Lakes Medical Center in Klamath Falls, Oregon (52 miles east-northeast of Copco). Other emergency responders are discussed in Section 3.17 Public Services.

3.21.2.6 Wildfires

Wildland fires represent a substantial threat to rural residences, timber, and other infrastructure or improvements located within the Klamath River watershed, particularly during the hot, dry summer months in areas where topography, land use, access, and heavy fuel loading contribute to hazardous conditions. During implementation of the Proposed Project, wildland fires may be started by natural processes, primarily lightning, or by human activities, including construction activities.

CALFIRE has established a fire hazard severity classification system to assess the potential for wildland fires[170]. The zones depicted on CALFIRE maps take into account the potential fire intensity and speed, production and spread of embers, fuel loading, topography, and climate (e.g., temperature and potential for strong winds).

The Proposed Project area along the Klamath River in Siskiyou County has been classified as having either high or very high wildfire hazard, with very high hazard land concentrated from the eastern portion of Copco No. 1 Reservoir to the Oregon border. (CALFIRE 2007). Under state regulations, areas within these very high fire hazard zones must comply with specific building and vegetation management requirements intended to reduce property damage and loss of life within these areas. Public Resources Code (PRC) 4291 requires a 100-foot defensible zone around each structure. It is these defensible spaces that CALFIRE notes (CALFIRE 2016) are the most effective way of reducing wildfire hazards to structures. Success only occurs under the combined efforts of strong fire suppression with aggressive and robust fire prevention activities (CALFIRE 2018).

Appendix B: *Definite Plan –Appendix O1 Fire Management Plan* contains a list of applicable fire suppression agencies and applicable regulations. The Fire Management Plan requires coordination with multiple city, county, state, and federal fire suppression agencies including USDA Forest Service, Bureau of Land Management (BLM), the Oregon Department of Forestry (ODF) Klamath-Lake District (KLD), Cal Fire - Siskiyou Unit (Cal Fire SU), local districts of Klamath and Jackson Counties in Oregon and Siskiyou County in California, and local city and volunteer fire stations. Fire safety and suppression resources are available from the various agencies in the event of a fire. In California, responsibility for wildfire prevention and suppression is shared by federal, state, and local agencies. Federal agencies are responsible for lands in Federal Responsibility Areas (FRAs). The State of California has determined that non-federal

[170] More information about CALFIRE's classification system is available online at: http://www.fire.ca.gov/fire_prevention/fhsz_maps_siskiyou (Accessed December 21, 2018).

lands in unincorporated areas with watershed value are of statewide interest and have classified those lands as State Responsibility Areas (SRAs), which are managed by CALFIRE. CALFIRE enforces their respective state laws and regulations and coordinate fire support with the local agencies. There are no Local Responsibility Areas (LRAs) (e.g., incorporated areas) near the Proposed Project area and less than two square miles of FRA's (see Figure 3.21-2). The Fire Management Plan (page 29) notes that KRRC's contractor would contact the CALFIRE SU Prevention Specialist during development of detailed, site-specific fire management plans and would be in frequent contact with the pertinent fire suppression agencies during construction to discuss fire hazards, prevention, suppression, and contingency plans.

Siskiyou County is located in the CALFIRE Siskiyou Unit. The CALFIRE Siskiyou Unit encompasses 1.2 million acres of ecologically diverse wildlands. Most of the large fires in the CALFIRE Siskiyou Unit over the past 50 years have been wind-driven fires. Lightning, equipment use, and debris burning have historically been the determined primary ignition sources for these large fires (CALFIRE 2016).

As discussed in Section 3.17 *Public Services*, the Proposed Project area is located within the Shasta Valley Battalion (Battalion 2) of the CALFIRE Siskiyou Unit. Battalion 2 consists of two CALFIRE stations: one in the City of Yreka and one in the community of Hornbook; both stations provide fire protection services year-round. Paradise Craggy serves as the fire lookout for the Shasta Valley Battalion and is staffed with only emergency personnel during high-fire danger days and during and after lightning storms (CALFIRE 2016).

Fuel types consist of grass, brush, and timber that cover flat, rolling hills, and mountainous terrain. Battalion 2 includes a substantial wildland urban interface that includes many dispersed houses within the wildland areas. Much of the fire prevention efforts by Battalion 2 are focused on reducing the potential for large fire losses through public education and enforcement of Public Resources Code Section 4291, which requires up to 100 feet of fuel reduction around structures (CALFIRE 2016).

As shown in Table 3.21-3, approximately 10,624 acres burned between 2010-2015 in the CALFIRE Battalion 2 Unit SRA. In past years many of the Battalion's fires have started in LRA land and have threatened to burn SRA land. These fires were found to have the same causes as the SRA fires. (CALFIRE 2016). Wildfires originating in Oregon (such as the Oregon Gulch Fire in 2014) in the vicinity of the Klamath River also pose hazards to structures and public health within and adjacent to the Proposed Project area. Of note, from the below tables, the Oregon Gulch Fire burned 9,464 acres in California, meaning only 1,160.55 acres burned as a result of lightening fires the remaining six years. The next two largest categories for acres burned are from debris burning and equipment.

Table 3.21-3. 2010–2015 Battalion 2 Fire Causes.

Shasta Valley Battalion 2010-2015 Causes	Number by Cause	Acres Burned
Undetermined	38	31.6
Lightning Fires	55	10,211.68
Campfire	7	0.22
Smoking	3	0.21
Debris Burning	65	2.5
Debris Burning with Escape	18	130.93
Arson	13	3.15
Equipment	22	223.45
Playing With Fire	3	0.30
Vehicle	9	10.05
Railroad	0	0
Electrical Power	5	7.4
Miscellaneous/Other	16	3.06
Totals	**254**	**10,624.55**

Source: CALFIRE 2016

CALFIRE Incident Information (CALFIRE 2018) noted the following wildfires that occurred in the general area of the Proposed Project between 2010 and 2018.

Table 3.21-4. 2010–2018 Incident Information.

2010–2018 Incidents	Date of Incident	Acres Burned
Dutch Fire	July-August, 2010	371
Oregon Gulch Fire	July, 2014	9,464 in CA
Bogus Fire	June, 2017	56
Klamathon Fire	July, 2018	38,008
Iron Gate Fire	October, 2018	15

Source: CALFIRE 2018

During the dry season, areas surrounding the Proposed Project are at risk for fires, particularly at the interface between residential development and open space. The fire threat is high to very high in the areas surrounding the Proposed Project (CALFIRE 2007). The Klamathon Fire that started in July 2018 and burned 38,008 fires resulted in 82 structures destroyed, 12 structures damaged, one fatality and three injuries. Fire suppression is dependent on both air drops and ground crews, requiring a readily available source of water for helicopter fire suppression and ground crews fighting fires in the vicinity of the wildfire. The use of fire retardant, from fixed wing aircraft, is replenished from nearby airports or other places that aircraft can land and not dependent on sources of water.

Fire protection in the area of analysis is provided by federal agencies, the state forestry and fire prevention agencies, and a variety of city, county, and volunteer fire stations. Federal agencies include the USDA Forest Service, which is responsible for wildland fire protection on National Forest lands and providing assistance to other federal entities when requested, and the BLM, which is responsible for wildland fire protection on land managed by the BLM and for providing assistance to other federal, state, and local agencies when requested.

Fire protection at the state level is provided by CALFIRE in California, who, in conjunction with county and volunteer fire departments, is also responsible for fire protection throughout the unincorporated areas of the state. As discussed above, there are two CALFIRE stations in the vicinity of the Lower Klamath Project; Yreka, and Hornbrook. In Oregon, the Oregon Department of Forestry responds to wildland fires in the state resource areas and on federally managed lands. The Oregon Department of Forestry works with the BLM and the USDA Forest Service to prevent and fight wildfire on the federally managed lands as well.

City-operated fire stations include the Yreka Fire Department and the Mount Shasta Fire Department. There are also county fire stations throughout the Proposed Project area, including the Copco, Happy Camp, Seiad Valley, Etna, Fort Jones, Montague, Butte Valley, McCloud, Dunsmuir, and Mount Shasta fire departments (CPF Fire Department Directory 2017). The nearest fire stations to the Proposed Project area are the Copco Fire Department, Keno Rural Fire Protection District Station (in Oregon east of Keno Dam), Yreka Fire Department, and the Colestin Rural Fire Protection District (in Oregon northwest of Iron Gate Dam). The Colestin Rural Fire Protection District and the Hilt Fire Company in Northern California operate as one agency out of geographic necessity. Legally, however, they are two separate entities. The Hilt volunteer fire department jurisdiction includes the California side of the Colestin Valley, and also part of northern Siskiyou County, down to the Hornbrook boundary (Colestin Rural Fire District 2017). Each of these stations would have their own localized source of water for keeping their equipment full, but most would dependent on the reservoirs, the Klamath River, or other streams and sources for refilling at sources closer to a particular fire.

According to Appendix B: *Definite Plan –Appendix O1 Fire Management Plan*, the Fire Management Plan would include, among other items, details on: (1) establishing effective communication links between fire protection services and all personnel on the Proposed Project site; (2) compliance with all applicable regulations and federal and state guidelines (including CALFIRE 1999); (3) assessing weather conditions; (4) identifying all fire suppression infrastructure and emergency resources; (5) coordinating with nearby fire protection services; (6) routinely checking all fire abatement equipment and water storage on site; (7) establishing an up-to-date map of current helicopter fire suppression resources throughout the construction period; and (8) construction, utilizing, and maintaining proposed dry hydrants.

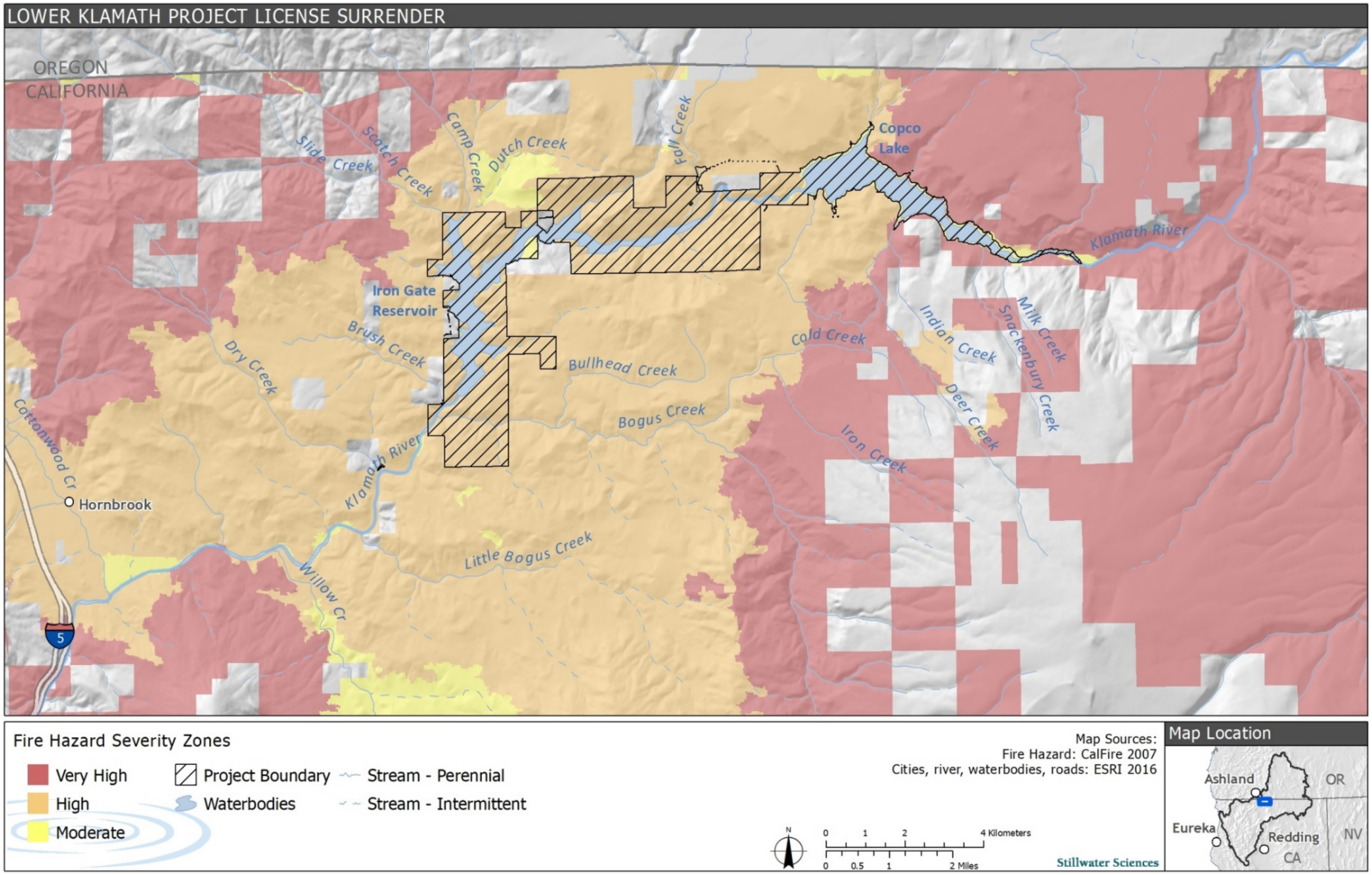

Figure 3.21-2. Map of CALFIRE Fire Hazard Severity Zones with Proposed Project Boundary Depicted (Source: CALFIRE 2007).

3.21.3 Significance Criteria

Criteria for determining significance of hazards and hazardous materials is informed by Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and based on professional judgment. Effects of hazards and hazardous materials are considered significant if the Proposed Project would result in one or more of the following:

- Substantial exposure to hazardous materials, where substantial is defined as quantities of hazardous, or acutely hazardous, materials that would be harmful to the public or the environment.
- A substantial safety hazard for people residing or working in the Area of Analysis due to an increase in the risk of air traffic accidents.
- Impaired implementation of, or physical interference with, an adopted emergency response plan or emergency evacuation plan that would result in harm to the public or to the environment.
- A substantial increase in the risk of loss, injury or death involving wildland fires.

3.21.4 Impact Analysis Approach

The approach to impact analysis for hazards and hazardous materials includes an evaluation of the Proposed Project's transport, use, disposal and potential release of hazardous materials within the context of existing environmental setting. This section also describes the proximity of Proposed Project activities to schools, evaluates the existing known and unknown contaminants and contaminated sites within the Area of Analysis for hazards and hazardous materials, identifies airport locations, evaluates emergency response plans, and addresses wildfire hazards.

The analysis of the Proposed Project primarily focuses on the short-term construction-related activities and impacts that would cause the removal of existing hazardous materials. An increased need for emergency services is likely during construction activities and, as described in Section 3.22 *Transportation and Traffic*, project-related equipment and debris hauling may conflict with the ability to provide required emergency services. Consideration has been provided for the potential for accidental release of hazardous materials during routine transport along roadways that would be shared with public vehicles, where the latter could include school busses when school is in session (September to June). The analysis of wildfires considers the potential increase for wildfires during construction activities and as a result of restoration activities, as well as potential long-term impacts related to the loss of the reservoirs for future fire-fighting purposes.

The potential for aquatic species and human exposure to inorganic and organic contaminants due to sediment release associated with dam removal under the Proposed Project is discussed in Section 3.2.5.7 *Inorganic and Organic Contaminants*.

Local regulations pertaining to impacts analyzed in this section include Siskiyou County General Plan policies (i.e., Policies 30 Wildfires, 41.9 Adequate access) and solid waste regulations such as the Countywide Source Reduction and Recycling Element and Siskiyou County Code of Ordinance Title 5, Chapter 1 Garbage and Refuse Disposal. Other local regulations that may indirectly pertain include those of the Siskiyou County Environmental Health Department, and the Siskiyou County Air Pollution Control District.

3.21.5 Potential Impacts and Mitigation

Potential Impact 3.21-1 Proposed construction-related activities could result in substantial exposure to hazardous materials through the routine transport, use, or disposal of hazardous materials.

The Proposed Project would not result in the long term routine transport, use, or disposal of hazardous materials since the Proposed Project is the removal of existing dams and their associated hydroelectric facilities, and, once completed, the Proposed Project would not involve the continued use, transport or disposal of hazardous materials. However, in the short term, construction-related dam removal would involve routine transport, use, and disposal of general construction waste materials (e.g., concrete, rebar, building waste, power lines; see also Appendix B: *Definite Plan – Sections 5.3–5.5*) and some hazardous materials (e.g., treated lumber, asbestos, lead, PCBs, fuels, gases, etc.) would be encountered, used, transported and disposed of during those construction activities.

The Proposed Project Phase 1 Environmental Site Assessment for hazardous materials is underway but has not yet been completed. A Phase 2 Environmental Site Assessment for hazardous materials would be undertaken, as needed. Existing information regarding hazardous waste associated with the Lower Klamath Project dams and its facilities indicates that creosote or other treated wood is present, including 700 tons of treated wood waste from the wooden-stave penstock at Copco No. 2 Dam, as well as batteries, possible PCBs from transformers and other electrical equipment, asbestos-containing materials in building materials, fuels and oils, flammable and combustible liquids, flammable and nonflammable gases, corrosives, concrete dust (if it generates high pH waste), and soils or other material contaminated with lead from the use of lead-based paints or plumbing (see additional detail in Appendix B: *Definite Plan – Appendix O3*).

Demolition and disposal of structures containing the aforementioned hazardous materials, or others determined as part of Phase 1 investigations (and Phase 2, as needed), under the Proposed Project could result in exposure to quantities of hazardous, or acutely hazardous, materials that would be harmful to the public or the environment due to accidental releases and thus could result in a significant impact. Operation of construction equipment in close proximity to aquatic environments could involve equipment failures that would also result in the public or the environment being exposed to hazardous materials due to petroleum spills. Because the Proposed Project is located in a sensitive environment (i.e., along the Klamath River) and consists of substantial demolition activities, the increased amount of construction-related activity relative to existing conditions would increase the risk of exposing the public or the environment to quantities of hazardous, or acutely hazardous, materials that would be harmful. This would be a significant impact.

The Proposed Project includes an assessment of roads, intersections, bridges and culverts (Appendix B: *Definite Plan – Appendix K*) within the Area of Analysis for hazards and hazardous materials and proposes a number of improvements to help reduce the potential for accidental release of hazardous materials during transport of these materials to and from the dam sites. The proposed replacements and upgrades to transportation structures, as well as proposed construction-related traffic management, including signage, flaggers, and traffic coordination (Appendix B: *Definite Plan –*

Appendix O2), would reduce the risk of traffic accidents that could result in exposure to quantities of hazardous, or acutely hazardous, materials that would be harmful to the public or the environment.

Further, existing federal and state regulations require the KRRC and its construction contractors to undertake a number of measures related to hazardous materials. KRRC is developing a dam safety program that would ensure that removal of the Proposed Project would be undertaken in a manner that minimizes risk to people, structures, infrastructure, and the natural resources of the Klamath River Basin (Appendix B: *Definite Plan – Section 3*). Such removal would fully comply with FERC's dam safety requirements, and it would be consistent with FERC Engineering Guidelines (FERC 2017). In addition, the below list of state and federal regulations include requiring, for example, that the KRRC and its contractors keep an inventory of hazardous materials at each dam facility and the intention for final disposition of these materials. The KRRC and its contractors are required to describe the storage, spill prevention, and cleanup measures, including the deployment and maintenance of spill cleanup materials and equipment at each facility/site to contain any spill from Proposed Project activities. Onsite containment for storage of chemicals classified as hazardous is required to be away from watercourses and include secondary containment and appropriate management as specified in California Code of Regulations, Title 27, Section 20320.

The KRRC and its contractors are also required to comply with the terms and conditions in the State Water Board's *National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities* (Construction General Permit; State Water Board Order 2009-0009-DWQ, as amended by State Water Board Orders 2010-0014-DWQ and 2012-0006-DWQ), and ongoing amendments during the life of the Proposed Project.), Hazardous materials, substances, and waste within the Area of Analysis for hazards and hazardous substances are regulated by several other federal and state laws and policies, some of which are listed below. Compliance with required regulations would substantially minimize the potential impact of hazardous materials on the public and the environment during the routine transport, use, or disposal of hazardous materials.

Federal Regulations

- Resource Conservation and Recovery Act (42 USC 6901 et seq.)
- Hazardous Materials Transportation Act (49 USC Section 1801 et seq.)
- Clean Water Act (33 USC 1251 et seq.)
- Comprehensive Environmental Response Compensation and Liability Act and
- Superfund Amendment Reauthorization Act (SARA) (43 USC 9601 et seq.)
- 40 CFR 260-279 Federal Regulations on hazardous waste management
- 40 CFR 301 et seq. Emergency Planning and Community Right to Know Act
- Toxic Substances Control Act (15 USC 2601 et seq.)

State Regulations

- California Hazardous Waste Control Law (California Health and Safety Code [HSC] Section 25500 et seq.)
- Carpenter-Presley-Tanner Hazardous Substances Account Act (HSC Section 25300 et seq.)

- Unified Hazardous Waste and Hazardous Materials Management Regulatory Program (HSC Section 25404 et seq.)

The Proposed Project also includes Appendix B: *Definite Plan – Appendix O3 Hazardous Materials Management Plan*. The Hazardous Materials Management Plan states that all hazardous materials removed within the Project Boundary would be either returned to the vendor, recycled, or managed and disposed of as hazardous waste at an approved hazardous waste facility in accordance with applicable regulations. Transformer oils would be tested for PCBs if no data exist. Any tanks that contain hazardous materials would be decontaminated prior to disposal. Universal hazardous waste (e.g., lighting ballasts, mercury switches, and batteries) would be handled per applicable federal and state universal waste regulations. The Hazardous Materials Management Plan notes that any additional hazardous materials noted during the Phase 1 site visits and Phase 2 investigations would be included in an updated Hazardous Materials Management Plan and the contractor would sample and test for asbestos, lead and PCB's at all structures to be removed. The Hazardous Materials Management Plan is required to comply with, among other regulations, California Health and Safety Code, title 27, division 20, chapter 6.95, sections 25500 through 25545, and California Code of Regulations title 19, division 2, chapter 4.

Overseeing development and implementation of the Final Hazardous Materials Management Plan falls within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to be consistent with the water quality certification from California, at this time the Hazardous Materials Management Plan is not finalized. Therefore, implementation of Mitigation Measure HZ-1 is required to reduce the short-term, construction-related risk of exposing the public and/or the environment to harmful quantities of hazardous, or acutely hazardous, materials during their transport, use, and disposal under the Proposed Project to less than significant.

Mitigation Measure HZ-1 – Hazardous Materials Management.
No later than six months following issuance of the FERC license surrender order, and prior to the start of pre-dam removal activities and any construction activities, the KRRC shall submit a Final Hazardous Materials Management Plan (Final Hazardous Materials Management Plan) to the State Water Board Deputy Director for review and approval. The State Water Board has authority to review and approve any final Hazardous Materials Management Plan through its water quality certification under Clean Water Act Section 401. The State Water Board has issued a draft water quality certification[171] which sets forth monitoring and adaptive management requirements for any Hazardous Materials Management Plan to meet, as Condition 11. Additionally, the Oregon Department of Environmental Quality has issued a water quality certification[172] that sets forth water quality monitoring and adaptive management conditions for points upstream of California.

[171] The State Water Board's draft water quality certification is available online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lower_klamath_ferc14803/lkp_dwqc.pdf (Accessed December 19, 2018).
[172] The Oregon Department of Environmental Quality's final water quality certification is available online at: https://www.oregon.gov/deq/FilterDocs/ferc14803final.pdf (Accessed December 21, 2018).

Consistent with the above, the Final Hazardous Materials Management Plan shall include any modifications to the proposed Hazardous Materials Management Plan developed in coordination with State Water Board staff that provide the same or better level of protection regarding procedures for proper disposal or abatement of hazardous materials encountered during Proposed Project activities; proper storage, containment, and response to spills caused by the Proposed Project; and proper removal and disposal of septic tanks as part of the Proposed Project.

The Final Hazardous Materials Management Plan shall also describe how the elements of the KRRC's proposed Health and Safety Plan (Appendix B: *Definite Plan – Appendix O4*), the Spill Prevention, Control, and Countermeasure Plan (Appendix B: *Definite Plan – Appendix O4*), the Emergency Response Plan (Appendix B: *Definite Plan – Appendix O4*), and the Traffic Management Plan (Appendix B: *Definite Plan – Appendix O2*) are coordinated together, and as such, adequately protect water quality with respect to hazardous materials management.

The KRRC shall implement the Final Hazardous Materials Management Plan upon receipt of State Water Board Deputy Director approval and any changes to the Hazardous Materials Management Plan must be approved by the State Water Board Deputy Director prior to implementation.

The KRRC shall provide monthly reporting to the State Water Board detailing the volumes of hazardous materials and wastes that were cleaned up and disposed of from site construction activities and any other modifications to the proposed Hazardous Materials Management Plan developed in coordination with State Water Board staff.

Significance

No significant impact with mitigation

Potential Impact 3.21-2 Proposed construction-related activities could result in substantial exposure to hazardous materials through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment.

See also discussion under Potential Impact 3.21-1. A reasonably foreseeable condition that could result in an upset involving the release of hazardous materials into the environment would occur from such natural events, such as earthquakes, floods or fires or from accidents during construction activities. Fuel storage tanks used for construction could rupture or spill and hazardous materials could be carried away by floodwaters. Proposed Project workers, the public sharing the roads with construction vehicles, and/or the environment could be exposed to harmful levels of hazardous materials due to accidental releases during construction activities. Accidental release of hazardous materials (from vehicle fuels, solid waste, materials and supplies) could also occur during transport as a result of vehicular accidents due to increased construction-related traffic and/or as a result of inadequacies in the capacity, design or traffic control of the roads that would be used for construction-related activities (Figure 3.22-1). Any of these situations under the Proposed Project would result in a significant impact.

Appendix B: *Definite Plan – Appendix O2 Traffic Management Plan*, *Appendix O3 Hazardous Materials Management* and *Appendix O4 Emergency Response Plan* complement one other with respect to pre-planning and response efforts to minimize the risk of potential upset and accident conditions involving the release of hazardous materials. Since the responsibility of finalizing these plans fall on the KRRC and the construction contractors, Mitigation Measure HZ-1 assures that the contractor(s) are aware of the federal and state requirements and submit updated plans that are geared towards their strategies and methods for addressing this issue.

With implementation of Mitigation Measure HZ-1, impacts due to potential upset and/or accidental release of hazardous materials that result in substantial exposure to the environment during the proposed short-term, construction-related activities would result in a less than significant impact.

Significance

No significant impact with mitigation

Potential Impact 3.21-3 Proposed construction-related activities could result in substantial exposure to hazardous materials through emissions or handling of substances or waste within one-quarter mile of an existing or proposed school.
Hazardous emissions and acutely hazardous materials generally can have a greater impact than other types of hazardous materials, especially if they are present within one-quarter mile of a school. There are no hazardous emissions proposed from a manufacturing process under the Proposed Project. Short-term operational emissions due to construction-related activities under the Proposed Project are discussed in Section 3.9 *Air Quality and Section 3.10 Greenhouse Gases*. Hazardous materials and wastes are addressed in Potential Impacts 3.21-1 and 3.21-2.

Existing schools are more than five miles away from construction-related activities (Section 3.21.2.2 *[Hazards and Hazardous Materials] Environmental Setting – School Proximity*), thus the Proposed Project would not involve handling of hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of a school.

Significance

No significant impact

Potential Impact 3.21-4 The Proposed Project could be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, could result in substantial exposure to hazardous materials.
The Proposed Project is not located on a site which is currently included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5. However, no Phase 1 or 2 reports have been submitted to make the determination of whether portions of the Proposed Project Area should be included on the lists. The type of use and activities and the length of time these activities have been occurring within the Proposed Project Area suggest the possibility that contaminated sites/soils exist on site. Therefore, the risk remains that contaminants exist on the site that could result in a substantial exposure that would be harmful to the public or the environment. The Proposed Project could also result in a significant impact if the project involved activity in areas that contained contaminated substances that would result in substantial exposure to the public or the environment. Crucial to this analysis would be the analysis of what contaminants exist on the site. This is typically ascertained by completion of a Phase 1 Environmental Analysis and, when necessary, a follow up with a Phase 2 Environmental Analysis.

Appendix B: *Definite Plan – Appendix O3*, Table 1 identified contaminated soils as a type of hazardous material that could be present at each dam location. As noted in Section 3.21.2.3 *Contaminants/Contaminated Sites*, there are several sites that may be contaminated with hazardous substances in the vicinity of the Proposed Project. Thus, the Proposed Project could result in an impact from known and unknown contaminants if, during construction activities, these materials are not handled and disposed of properly (i.e., according to state and federal regulations). For instance, dioxins and dioxin-like substances, including PCBs, are persistent in the environment and accumulate in the food chain. Human exposure to dioxins has been associated with a range of toxic effects. They are also a known human carcinogen. PCBs are found in industrial oils, old electric transmission lines, and substations. PCBs are currently listed as a potential type of hazardous waste present at the Copco No. 1, Copco No. 2, and Iron Gate dams (Appendix B: *Definite Plan – Section 5*). If these contaminants are present in the soil in substantial quantities there is the potential for exposure at levels that would be harmful to the public or the environment. This would be a significant impact.

Based on the age of the structures at Iron Gate Dam, the concrete in the structures may contain fly ash, which has raised concerns in the past about the presence of mercury or other toxic substances. Without proper protections, these contaminants can leach into groundwater and potentially migrate to drinking water sources, posing public health concerns. While USEPA recognizes the beneficial uses of fly ash and considers it safe when it is encapsulated in concrete or other building materials (USEPA 2016), construction activities include drilling and cutting into the large quantities of concrete slated for removal under the Proposed Project (i.e., greater than 100,000 yd^3) (Table 2.7-3, Table 2.7-4, and Table 2.7-7) could result in dust that releases toxic substances and would be harmful to the public or the environment. This would be a significant impact.

In addition to the measures included in the Proposed Project, Mitigation Measure HZ-1 would be necessary to ensure that adherence to existing regulations are included in contractor bid documents. This includes that the findings of the Phase 1 and Phase 2 Environmental Site Assessment reports would need to be added to the Hazardous Materials Management Plan and Health and Safety Plan. With implementation of Mitigation Measure HZ-1, potential impacts due to exposure to hazardous materials during the proposed construction-related activities would be less than significant.

Significance

No significant impact with mitigation

Potential Impact 3.21-5 The Proposed Project could result in, for a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, a substantial safety hazard for people residing or working in the project area due to a risk of traffic accidents.

Potential Impact 3.21-6 The Proposed Project could result in, for a project within the vicinity of a private airstrip, a substantial safety hazard for people residing or working in the project area due to a risk of traffic accidents.

The below analysis applies for both Potential Impacts 3.21-5 and 3.21-6.

The Proposed Project could result in a substantial safety hazard from air traffic accidents if it was located near an airport's area of influence or resulted in height obstructions that would result in air traffic accidents. Siskiyou County Airport is more than 10 miles south of Iron Gate Dam in Montague. Pinehurst State Airport in Oregon is located approximately nine miles north of Copco No. 1 Reservoir. There are no public or private airports within two miles of the Lower Klamath Project nor would any activities of the surrounding airports or airfields adversely affect the Proposed Project area. The 2001 Siskiyou County Airport Land Use Compatibility Plan does not extend as far north as the Proposed Project. There is also no aspect of the Proposed Project that would adversely affect any nearby airports or private airstrips. (see also Section 3.21.2.4 *Nearby Airports*). Overall there would be no impact.

Significance

No significant impact

Potential Impact 3.21-7 Proposed construction-related activities could impair implementation of, or physically interfere with, an adopted emergency response plan or emergency evacuation plan.

The Proposed Project would not directly conflict with any adopted emergency response plan or emergency evacuation plan. However, the Proposed Project could result in short-term construction-related impacts consisting of an increase in traffic on narrow rural roads from commuting workers, hauling of large equipment and disposal of wastes. This additional traffic could result in interference to emergency response vehicles as well as create a situation requiring additional need for emergency response due to personal and vehicular accidents, natural and worksite caused fires, and accidental releases of hazardous materials. This would be a significant impact. To prevent or reduce impacts to emergency response, a carefully orchestrated plan that avoids interfering with off-site emergencies as well as accommodates the need for emergencies resulting from the Proposed Project needs to be developed and disseminated amongst both workers and responders.

The Proposed Project (Section 2.7.8.11 *Emergency Response*) contains a brief description of an Emergency Response Plan (for details see Appendix B: *Definite Plan–Appendix O4*). According to that document, construction contractors would be required to develop a Final Emergency Response Plan to develop and implement procedures to help prevent incidents, to ensure preparedness in the event incidents occur, and to provide a systematic and orderly response to emergencies. The Final Emergency Response Plan needs to be closely coordinated with the contractor's Health and Safety Plan, Spill Prevention and Response Plan, Traffic Management Plan, and Fire Management Plan. Procedures documented in the Final Emergency Response Plan would apply to all personnel working on site. Prior to commencing construction activities, the contractor's Health and Safety lead would review emergency response procedures with all personnel assigned to the site to the extent necessary.

Applicable emergency scenarios include, but are not limited to, the following:

- Medical emergency
- Fire management
- Traffic incident
- Hazardous material spill management

- Downstream hydraulic change planning (e.g., flooding-related hazards)
- Dam or tunnel failure
- Catastrophic emergency (e.g., earthquake, high wind event, etc.)
- Security threat

Each type of emergency and its associated plan requirements are discussed in more detail in Appendix B: *Definite Plan – Appendix O4* Emergency Response Plan.

An increased need for emergency services may occur during peak construction activities under the Proposed Project, and, as described in Sections 3.17 Public Services and 3.22 *Transportation and Traffic*, this may conflict with the ability of entities to provide those services. As discussed in Section 3.21.2 *Environmental Setting* (as well as Section 3.22 *Transportation and Traffic*), there is the possibility that the combination of existing and project-related traffic may cause conflicts within the existing road system, preventing the level of emergency response that is available under existing conditions, particularly given the rural nature of the Area of Analysis for hazards and hazardous materials. This would be a significant impact. To reduce potential impacts all construction workers would require the knowledge and resources to adequately respond to emergencies, where emergency preparation and work should be overseen by a designated health and safety manager. In addition, responding agencies/departments should be made aware of the activities during the construction period so that they can implement their existing regulatory framework, establish an emergency contact process, and undertake inspections as needed throughout project implementation.

The draft Traffic Management Plan (Appendix B: *Definite Plan − Appendix O2)* further notes that the KRRC's contractor would perform a risk assessment of all intersections and roadways as part of the final Traffic Management Plan. Implementation of Recommended Measure TR-1 would require additional components beyond those listed as part of the Proposed Project (i.e., the final versions of the Traffic Management Plan and Emergency Response Plan) and these components would be necessary to adequately implement an Emergency Response Plan that addresses short-term construction-related impacts, consisting of an increase in traffic on narrow rural roads from commuting workers, hauling of large equipment and disposal of wastes, to the point that the potential impact would be less than significant.

Overseeing development and implementation of the final Traffic Management Plan and Emergency Response Plan, including measures described in Recommended Measure TR-1, does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to reach enforceable good citizen agreements that will be finalized and implemented, at this time the Traffic Management Plan and Emergency Response Plan are not finalized and the State Water Board cannot require their implementation. Accordingly, the State Water Board anticipates that implementation of the final Traffic Management Plan and Emergency Response Plan, including the aforementioned additional details in Recommended Measure TR-1 and any modifications developed through the FERC process that provide the same or better level of protection for transportation and traffic would reduce impacts to less than significant. However, because the State Water Board cannot ensure implementation of the final Traffic Management Plan and Emergency Response Plan, it has determined the impact in this Draft EIR to be significant and unavoidable.

Significance

Significant and unavoidable

Potential Impact 3.21-8 Proposed construction-related activities and/or removal of the Lower Klamath Project reservoirs could substantially increase the public's risk of loss, injury, or death associated with wildland fires.

The short-term potential for the public's increased risk from wildfires would occur during implementation of the Proposed Project if construction activities are not conducted consistent with adequately developed fire management and emergency response plans. As described under Potential Impact 3.21-7, providing all construction workers with the knowledge and resources for preventing and suppressing fires and requiring that all emergency preparation and work activities are overseen by a designated 'Safety Officer' would reduce the potential for short-term construction-related impacts of the Proposed Project to increase risk associated with wildland fires. The Proposed Project would be subject to a number of regulations and guidance documents, implemented by the various fire suppression services. Public Resources Code section 4423 et seq. include a number of requirements related to construction activities. CALFIRE's Industrial Operations Fire Prevention Guide (CALFIRE 1999) includes additional guidance.

Currently the Proposed Project includes versions of the Fire Management Plan and the Emergency Response Plan (Emergency Response Plan), leaving some of the details to the KRRC or selected contractor to provide. The Proposed Project Fire Management Plan (see Appendix B: *Definite Plan – Appendix O1*) responds to the above requirements and other fire prevention and response methods including fire precaution, pre-suppression, and suppression measures consistent with the policies and standards in the affected jurisdictions and provisions. The Fire Management Plan contains additional details, including the following bulleted items:

- Designate a Safety Officer
- Comply with all federal, state, and local regulations
- Assure fire suppression tools and water pumping systems on site
- Assure spark arresters on all equipment and vehicles
- Establish ongoing communication with fire suppression agencies
- Manage all work areas to reduce fire risk

Implementation of the proposed Fire Management Plan would result in a less than significant short-term construction-related impact because the measures contained within would substantially decrease the risk of wildland fires and hence the risk of loss, injury or death involving these fires.

Removal of the reservoirs as a source of water for fire suppression could substantially increase the public's risk of loss, injury, or death associated with wildfires if other sources of water are not readily available, and could result in an increased source of wildfire fuel in the form of dead trees around the former reservoir shorelines. Each of these potential impacts is discussed further below.

The Proposed Project would result in the removal of one readily available water source for wildfire services or increased emergency response times if other sources of water are not as readily available. Under the Proposed Project, removal of the Copco No. 1, Copco No. 2, and Iron Gate reservoirs would remove a long-term water source for fire suppression crews after the reservoirs are removed. The removal of the reservoirs could increase turn-around time for helicopters or ground crews refilling with water for fire abatement purposes. However, the initial response times for existing aircraft with fire retardant would not be changed by the loss of the reservoirs. Following dam removal, helicopters and ground crews would still be able to extract water from the Klamath River (both the current channel and the channel reaches to be exposed in the current reservoirs following drawdown), Lake Ewauna, and Upper Klamath Lake. Retrieving water directly from the Klamath River is consistent with how wildfires are suppressed along the Klamath River downstream of Iron Gate Dam under current conditions. Ground crews would be adversely affected unless access to Klamath River water continues to be supported under the Proposed Project. Loss of the reservoirs would not affect the use of fire retardant, which is loaded onto aircraft at regional airports (i.e., Redding, Montague, Klamath Falls) and then applied directly to wildfire sites.

With respect to Klamath River access, most helicopter water tanks require three feet of water depth to fill properly, so only deeper pools in the Klamath River would be able to be used by helicopters. CALFIRE uses the closest available water source that is suitable for fire-fighting, where suitability is determined by local conditions including water flow, depth of pool (2- to 3-foot minimum), amount of debris in pool, shoreline vegetation, and surrounding terrain. Rotor blade length and the length of bucket lines are also determinants, since there must be a safe amount of space to enter and exit the pool site. Individual pilots use their discretion to determine the closest and safest locations from which to withdraw water.

Analysis of aerial photos (Google Maps 2018) suggests the presence of pools with suitable conditions for helicopter filling in the currently free-flowing reaches of the Middle and Upper Klamath River, particularly in the reaches between Copco No. 1 and J.C. Boyle reservoirs and downstream of Iron Gate Dam. While source water would be available in the Klamath River in pools located in the river reaches exposed following reservoir drawdown, the travel time involved in accessing the newly formed pools would be greater than that for the existing Lower Klamath Project reservoirs because retrieval of water from relatively smaller, more narrow, river pools is more difficult than dipping directly from the broad water surface of a lake or reservoir, and only one helicopter at a time would have access to a given river pool versus multiple helicopters that can draw at one time from a large reservoir. Thus, response and travel times between water fills for helicopter crews would be expected to increase with the loss of the reservoirs. Wildfires can spread at a rapid speed, and involve high risks. Any amount of additional response time compared with existing conditions could result in a substantial increased risk of loss, injury, or death involving wildland fires and this would be a significant impact.

To compensate for the loss of reservoir water supply, the Proposed Project includes providing alternate water supply through dry hydrants that would be accessible to ground crews following removal of the dams. Flows in the Klamath River and tributaries are not expected to substantially change post-dam removal, as compared to current flows, and firefighting ground crews could still use the river as a water supply as long as physical access to water is provided. A dry hydrant is a passive, unpressurized system, with a screened intake placed in the channel above the channel bed. An above-ground fire hose is used to connect the intake to truck-mounted pumps (Figure 3.17-1). Placement of the dry hydrant must be in a location of satisfactory depth (during dry conditions), flow rate, and channel stability. The Definite Plan states that dry hydrants are commonly used as water supply for fighting fires in rural areas, and typical dry hydrants and fire truck pumps can supply over 1,500 gallons per minute, which is sufficient for rapid filling of typical water tankers and firefighting apparatus (Appendix B: *Definite Plan – Appendix O1*).

To assist ground-based firefighting efforts, the Fire Management Plan proposes the development of eight sites near the Copco No. 1 Reservoir and four sites near the Iron Gate Reservoir for installation of permanent dry hydrants from which water trucks and fire engines could draw directly from the Klamath River and larger tributaries (Figures 3.17-2 and 3.17-3). The Proposed Project also includes an evaluation of the potential for riverine pool features to be used for helicopter water filling and development of an associated map of resources that can be used by air-based firefighting crews.

The proposed dry hydrants are likely to be of limited use for firefighting compared with existing conditions because only ground crews can access them (i.e., they are of no use to aerial crews that can access the reservoirs under existing conditions). Hook-ups to the dry hydrants would require standard specifications and existing CALFIRE pumper trucks would require special equipment such as hard suction lines (a flexible hose would collapse) to successfully draft from the dry hydrants. The ground crews would need to be able to get close to the river to draft from the dry hydrants because firetrucks typically can only lift water over short vertical distances (i.e., 10 to 14 feet, with a maximum 15-foot height from the intake) and drafting from bridges may require too much lift. Decreased response time associated with dry hydrants as compared with aerial crew access of reservoir water via helicopters would be a significant impact since it would increase the risk of loss, injury, or death involving wildland fires. Direct withdrawal from the river using a boat ramp, pumping stations equipped with pumps connected to wells or deep pools in the river, above-ground storage tanks with ready access for transferring water to pumper trucks, are likely to be better options than the dry hydrants proposed by KRRC because these alternatives would be easier to use and thus would reduce ground crew response time. Section 3.17 *Public Services* includes Recommended Measure PS-1 that requires the KRRC or the Contractor's Safety Officer for the Proposed Project to submit a final Fire Management Plan after reaching agreement with CALFIRE Siskiyou Unit on a long-term water source replacement for helicopter and ground crews (including construction and utilization of proposed dry hydrants, dip ponds or other alternatives).

Loss of the Lower Klamath Project reservoirs could also increase the relative amount of dead woody vegetation compared with existing conditions, which would increase the fuel load by removing the reservoir shorelines and potentially affecting adjacent shallow groundwater levels. The potential for this effect would be limited to an approximate 300-foot wide band around the current reservoir shorelines, where root zones are within five to ten feet of groundwater. As noted in Section 3.5.2.1 *Vegetation Communities,* trees located outside of this 300-foot wide band would not be dependent on reservoir water as a significant source of water to tree roots. Conifers surrounding the reservoirs are considered drought-tolerant and would not be affected by the loss of the reservoirs but would remain as an existing fire hazard with or without the project. Riparian vegetation adjacent to tributary streams within the Area of Analysis for hazards and hazardous materials would continue to possess a source of water following dam removal since tributary stream flows would not be affected by the Proposed Project. In contrast, tree-dominated wet habitats surrounding the reservoir (i.e., Montane Riparian and Palustrine Forested Wetland [Section 3.5.2.1 *Vegetation Communities* and Appendix G]) would be likely to transition to upland habitats once the reservoirs are drawn down, and existing trees such as Oregon Ash and bigleaf maple may become snags or ultimately fall to the ground. While this increase in the relative amount of dead woody vegetation compared with existing conditions would increase the public's risk of loss, injury or death associated with wildland fires within the Area of Analysis, there is a relatively small proportion of these wet habitat types within the 300-foot buffer surrounding the Lower Klamath Project reservoirs (Figure 3.5-4 and 3.5-5). Montane Riparian and Palustrine represent three percent and six percent, respectively, of the vegetation in the 300-foot buffer surrounding Copco No. 1 and 2 reservoirs; Montane Riparian and Palustrine represent one percent and four percent respectively, of the vegetation in the 300-foot buffer surrounding Iron Gate Reservoir. This affected area, where woody vegetation may die off from loss of the reservoirs as a source of water, is limited in extent and would not substantially increase the risk of loss, injury or death involving wildland fires as a result of the loss of the reservoirs.

The measures included in the Fire Management Plan would reduce the potential for short-term, construction-related impacts of exposing people or structures, either directly or indirectly, to risk of loss, injury, or death involving wildland fires both during and immediately after the dams are removed, and there would be no significant impact. However, in the long term, the loss of the reservoirs, which are currently part of the existing conditions, would result in a substantial decrease in fire protection involving wildland fires due to longer response times and limitations on access to Klamath River water for fighting fires within the Area of Analysis for public services. While the proposed dry hydrants would provide a source of water to ground crews for firefighting, they do not offer the same degree of access as helicopter use of the reservoirs for wildfires occurring in the vicinity of the Lower Klamath Project, for which the reservoirs are the closest and safest source of water for aerial crews. One option that would assist in mitigating this impact would be to include appropriately placed dip ponds within the Proposed Project's restoration areas.

Recommended Measure PS-1 requires the KRRC and/or its Contractor(s) to develop, in consultation with the CALFIRE Siskiyou Unit, an updated Fire Management Plan that identifies long-term water sources for helicopter and ground crews (including construction and use of proposed dry hydrants, dip ponds, or other alternatives). Overseeing development and implementation of terms and conditions relating to fire management does not fall within the scope of the State Water Board's water quality certification authority. The State Water Board anticipates that in the absence of the reservoirs, the identification and use of alternative water sources (e.g., dip ponds, river pools suitable for helicopter drafting, dry hydrants) for both ground and helicopter crews that are developed through the FERC process would significantly ameliorate response times and provide a level of protection to substantially reduce the public's risk of loss from wildfires, thereby reducing impacts to less than significant in many instances. However, where suitable replacement water sources cannot be identified in close proximity to a fire in a location for which the reservoirs would otherwise have been the nearest water source, long-term impacts to the public's risk of loss from wildfires remain significant and unavoidable.

Significance

No significant impact in the short term

Significant and unavoidable impact in the long term

3.21.6 References

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3.22 Transportation and Traffic

This section describes the environmental setting for traffic and transportation, as well as potential environmental impacts and associated mitigation measures under the Proposed Project. The discussions in the following subsections focus primarily on regional and local roadways that provide access to Proposed Project facilities, traffic safety and road conditions, as well as public transit and non-motorized travel. Impacts evaluated herein focus primarily on the increased construction-related activities that the Proposed Project would create regarding traffic and transportation. While this section considers the sporadic activities that would occur throughout this period, the transportation and traffic focus is on the four- to six-month period during the peak of the construction-related activity, when removal activity would occur concurrently at each of the three California dams. Once the construction-related activity is completed, there will be no additional traffic generated by or directly related to the Proposed Project.

The State Water Board received a comment expressing safety concerns about Copco Road's serving as the primary access route to the Copco No. 1 Dam area and about the potential impacts of construction activities and traffic on the safety of other road users, including school busses, residents, pedestrians, livestock and dogs. The commenter expressed concern that Copco Road could be damaged during construction activities. The State Water Board did not receive other comments related to transportation and traffic and service systems during the NOP public scoping process (see Appendix A).

3.22.1 Area of Analysis

The Area of Analysis for transportation and traffic includes roadways in Siskiyou County, California, that would be used by construction vehicles and workers for, and could potentially be affected by, the Proposed Project. The Area of Analysis includes major access roads from Interstate 5 easterly to where Ager Beswick Road crosses the Oregon border. These roads are generally rural with low-density development. Most of the surrounding private property outside of the Proposed Project is undeveloped or used as grazing land for cattle, with the exception of several small communities in the vicinity of Copco No. 1 and Iron Gate reservoirs. Figure 3.22-1 depicts California roadways within the Area of Analysis for transportation and traffic that are analyzed in this chapter, and excludes other local roads that feed into this network because those local roads would not be used for transportation of construction equipment or workers and would not be affected by the Proposed Project The portion of Interstate 5 that may be affected by the Proposed Project is only partially depicted in Figure 3.22-1, but it is fully analyzed herein.

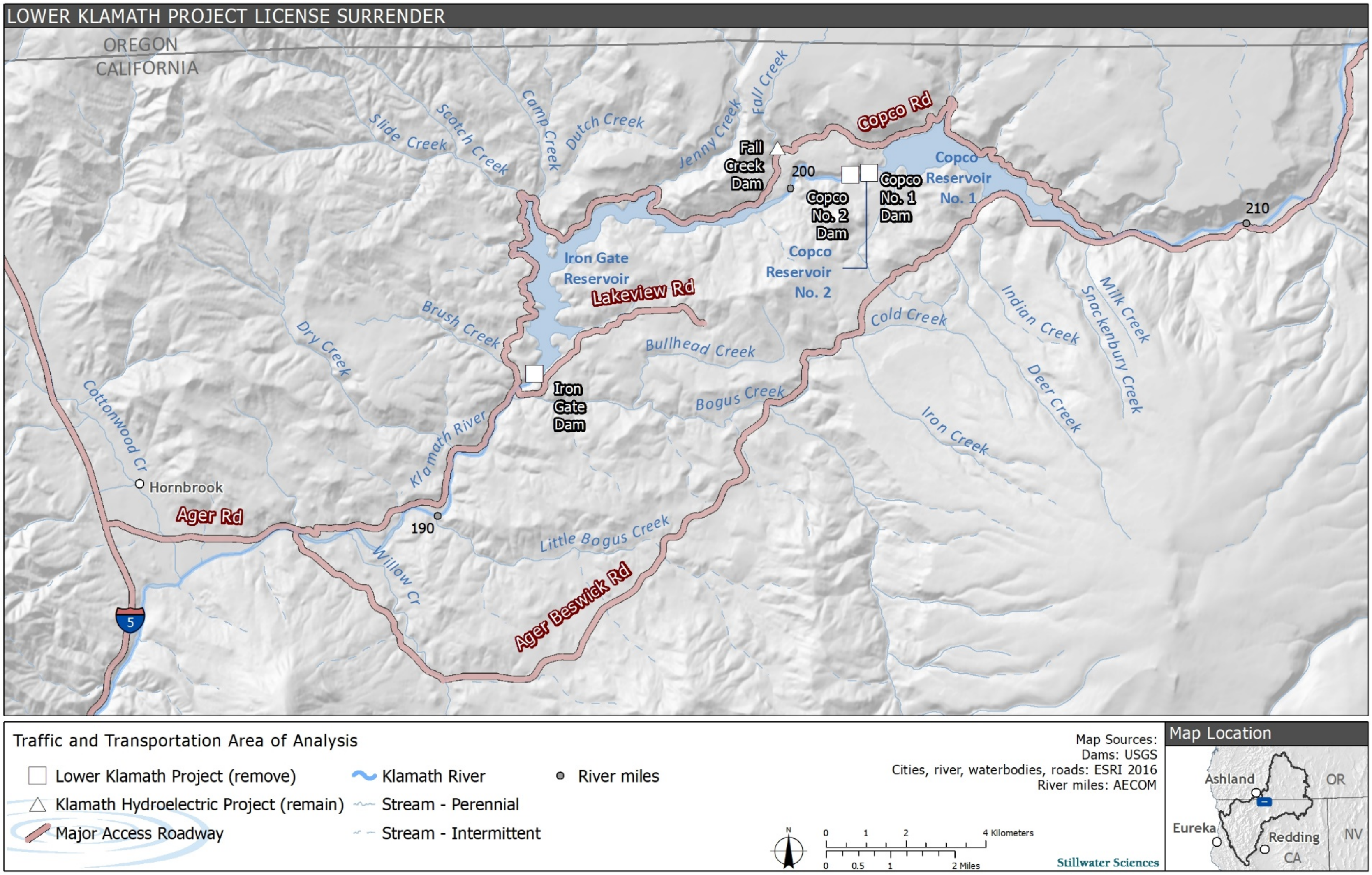

Figure 3.22-1. Traffic and Transportation Area of Analysis.

Table 3.22-1 lists the dam sites within the Area of Analysis for transportation and traffic, along with the corresponding regional and local roads that access each site. Under the Proposed Project, equipment hauling and waste disposal for J.C. Boyle Dam would occur only in Oregon (Appendix B: *Definite Plan*) and so traffic impacts associated with J.C. Boyle Dam are not analyzed herein.

Table 3.22-1. Major Local and Regional Access Roads within the Traffic and Transportation Area of Analysis.

Dam Site	Interstate Access Road	Regional Access Road	Local Access Road
Copco No. 1	I-5 (in California)	Copco Road	Ager-Beswick Road
Copco No. 2	I-5 (in California)	Copco Road	Ager-Beswick Road
Iron Gate	I-5 (in California)	Copco Road	Lakeview Road

3.22.2 Environmental Setting

This section describes the environmental setting associated with transportation and traffic within the Area of Analysis. For discussion of other related environmental resources areas, see Sections 3.9 *Air Quality*, 3.10 *Greenhouse Gas Emissions*, 3.14 *Land Use and Planning*, 3.17 *Public Services* and 3.21 *Hazards and Hazardous Materials*.

3.22.2.1 Traffic Flow

Roadways

Roadways in the Area of Analysis for transportation and traffic are classified as principal arterials, major collectors, minor collectors, and rural local roads. These roadway classifications are defined by the Siskiyou County Local Transportation Commission as follows:

- Principal arterials constitute routes whose design provides for high overall travel speeds with minimum interference to through movement. These routes serve long distance movements indicative of statewide or interstate travel. Principal arterials provide an integrated network that connects communities, regions, and other states.
- Major collectors provide service to larger towns not directly served by the arterial system, and to other traffic generators of equivalent intra-county importance, such as major recreational areas, schools, airports, and commercial activity centers. Additionally, they link these locations with nearby larger towns or cities and with higher classification routes.
- Minor collectors provide service to the remaining smaller communities within the county and link the locally important traffic generators with these rural areas.
- Rural local roads primarily provide access to adjacent land, and provide travel over relatively short distances as compared to arterials and collectors. Local roads constitute the remaining roadway mileage not classified as principal arterial, minor arterial, or collector roadways in Siskiyou County.

Primary access routes in the Area of Analysis for transportation and traffic that are likely to be affected by Proposed Project-related traffic are listed below and shown in Table 3.22-1 and Figure 3.22-1, above.

A discussion of road ownership and maintenance responsibilities is included in Section 3.14 *Land Use and Planning* (see also Figure 3.14-2).

Interstate 5 (I-5) is a major north/south interstate highway (principal arterial) that runs the length of California and is owned/maintained by Caltrans. This is a main regional access road for project facilities. I-5 is approximately 8 miles west of Iron Gate Dam. I-5 has four lanes through Siskiyou County. I-5 would be utilized for mobilization of construction equipment and as a haul route for carrying exported demolition materials. The alignment and pavement is in very good condition (Appendix B: *Definite Plan*). It would also serve as a route for workers commuting to the Proposed Project. Caltrans (2018a) traffic volume data from 2016 indicate that I-5 at Henley Way/Copco Rd (Exit 789) had 20,900 Annual Average Daily Traffic (AADT) in its peak month, and averaged 17,200 AADT.

Copco Road, some portions of which may be identified as "Juniper Road," "Ager Road," or "Iron Gate Lake Road" in some maps or documents, is a county-owned two-lane major collector in Siskiyou County that runs from I-5 to its intersection with Ager Road, where it then becomes a minor collector for the remainder of its length (Fehr and Peers 2011). Copco Road runs east from I-5 to Iron Gate Dam, where it turns north and parallels Iron Gate Reservoir to the Klamath River. From this point, Copco Road parallels the northern side of the Klamath River and Copco No. 1 Reservoir. Copco Road provides primary access to both Copco No. 1 and Copco No. 2 dams. Copco Road is a paved, two-lane road in generally good pavement condition between I-5 and Ager Road with few pavement cracks or ruts and is approximately 27 feet wide. Copco Road maintains this character from its intersection with I-5 east to a point about 10 miles from Copco No. 2 dam, near the Juniper Point Picnic Area. The condition of other portions of Copco Road are poorer that the segment between I-5 and Ager Road. For example, the section between the intersection of Copco Road with Ager Road and the Juniper Point Picnic Area contains intermittent pavement surfacing that has not been as well maintained as the portions to the west of Ager Road. (Additional information regarding the condition of roads in the vicinity of the Proposed Project is available in Appendix B: *Definite Plan – Appendix K*.) The final three miles, from Camp Creek Road near the Juniper Point Picnic Area to Copco No. 1 dam, are gravel and narrow, and less than 18 feet wide in some locations. The posted speed limit on Copco Road from I-5 to the Juniper Point Picnic Area is generally 55 mph with a few sharp curves, especially in the portions that run along the Iron Gate Reservoir. Posted speed limit is then reduced to 35 mph. Copco Road would be a primary access and hauling route for carrying exported demolition materials and for workers commuting to construction areas.

Roadways that could be accessed from Copco Road toward the Proposed Project include Ager Road, Ager-Beswick Road, Lakeview Road, Fall Creek Road, and other two-lane roads that provide access to residential and recreational areas. Copco Road, at its intersection with Ager Road, has approximately 485 AADT; Copco Road near Iron Gate Dam has approximately 216 AADT (Fehr and Peers 2011). Roadways described below connect to these road segments. Many sections of the local roads are posted for 25-35 mph or do not have posted speed limits.

Ager Road is a two-lane major county-owned collector that intersects Copco Road approximately three miles east of I-5 (Fehr and Peers 2011). Ager Road travels south to an intersection with Ager-Beswick Road.

Ager-Beswick Road is a county-owned two-lane minor collector that runs along the southern side of the Klamath River (Fehr and Peers 2011). It is accessed from Ager Road east of the downstream end of the Proposed Project or via a one-lane bridge that crosses from Copco Road over Copco No. 1 Reservoir at the upstream (easterly) end of the Proposed Project.

Lakeview Road is a rural local road that accesses Iron Gate Dam. Lakeview Road intersects with Copco Road at the entrance to the Iron Gate Recreation Area. A one-lane bridge crosses the river at this intersection, linking it to Lakeview Road. Lakeview Road is a gravel road that leads up to the top of Iron Gate Dam. It is approximately 24 feet wide and has a steep embankment on the east side, without a guardrail. Lakeview Road connects to an unnamed bridge access road. The narrow, gravel access road leads onto the top of Iron Gate Dam. For the purposes this analysis, Lakeview Road would be considered an unpaved access road except when discussing the bridge.

Fall Creek Road is a rural local road that intersects with Copco Road and provides access to Fall Creek Dam.

Unpaved access roads include a small network of one-lane, gravel access roads leading from Copco Road to each of the dams. These roads, the majority of which are owned by PacifiCorp, are no wider than 15 feet and are no longer than half a mile. Most of the traffic along these roads consists of PacifiCorp's technicians accessing the facilities, recreational users, or local residents. See Figure 2.7-2 and Appendix B: *Definite Plan − Appendix K* for additional details on locations and conditions of these roads.

Regional Transportation Plan

The Siskiyou County Local Transportation Commission (SCLTC) is the designated Regional Transportation Planning Agency for Siskiyou County. The County is within the jurisdictional boundaries of California Department of Transportation (Caltrans) District 2, located in Redding. The SCLTC, along with Caltrans District 2, fulfills the transportation planning responsibilities for Siskiyou County. One of the main responsibilities of the SCLTC is the preparation and approval of the Regional Transportation Plan. The 2016 Regional Transportation Plan serves as the planning blueprint to guide transportation investments in Siskiyou County involving local, state, and federal funding over the next twenty years. This assures that proper planning for traffic flow, including assessing road conditions and multimodal transportation needs, is implemented.

The 2016 Regional Transportation Plan includes:

- A Policy Element (Chapter 3) describing the transportation issues in the region, identifies and quantifies regional needs expressed within both a short- and long-range framework, and maintains internal consistency with the financial element fund estimates.
- An Action Element (Chapter 4) that identifies plans to address the needs and issues for each transportation mode in accordance with the policy element.

- A Financial Element (Chapter 5) that identifies the current and anticipated revenue sources and financing techniques available to fund the planned transportation investments describes in the action element. The intent is to define realistic financing constraints and opportunities.

The County's Regional Transportation Plan incorporates a number of local and state planning efforts to implement the County's policy to support the development and maintenance of an efficient, safe and effective road system. The 2016 Regional Transportation Plan incorporated information from the following plans and studies.

- Siskiyou County Regional Transportation Plan (2010)
- Siskiyou County Circulation Element Goals (1988)
- Siskiyou County General Plan (1988)
- Ten-Year State Highway Operation and Protection Plan (SHOPP Plan) (2015)
- Siskiyou County Unmet Transit Needs (2015)
- STIP Fund Estimate, CTC (Jan 2016)
- California Strategic Highway Safety Plan (2015)
- Siskiyou County Coordinated Public Transit-Human Services Transportation Plan (2014)

Level of Service

Operation of the roadway system typically is described in terms of Level of Service (LOS). LOS is a quantitative indication of the level of delay and congestion experienced by motorists. LOS is designated by the letters "A" through "F." LOS A corresponds to the lowest level of congestion, where individuals are virtually unaffected by the traffic stream, and LOS F corresponds to the highest level of congestion and the forced breakdown of flow.

The 2016 Siskiyou County Transportation Plan (Greendot 2016) provides AADT thresholds for general classes of roadways and projected volumes from the present to the year 2035. By comparing AADT for measured roads within the Area of Analysis for transportation and traffic with the capacities of those roadways, Greendot (2016) indicates acceptable LOS determinations for those roadways (Table 3.22-2).

Table 3.22-2. Maximum Daily Volume Thresholds for Roadway Classes.

Classification	Level of Service (LOS)* (vehicle trips)				
	A	B	C	D	E
4-Lane Major Freeway	25,400	41,600	58,400	71,000	79,200
2-Lane, Class I Highway	1,200	3,700	7,600	13,600	21,000
2-Lane, Class II Highway	1,700	4,100	8,200	16,600	21,200
Rural Principal Arterial (2 lane)	2,600	5,900	10,300	16,900	20,200
Rural Minor Arterial (2 lane)	1,200	3,300	6,400	11,000	15,500
Rural Major Collector (2 lane)	1,300	3,900	7,500	12,600	16,900
Rural Minor Collector (2 lane)	1000	3,000	5,500	8,750	11,200
Rural Local Road	600	2,000	3,500	4,900	5,500

* Based on the 2010 Highway Capacity Manual, which provided maximum peak hour flows. The values in this table were converted to daily travel using the peak period percent (approximately 10 percent) for these facilities (Greendot 2016).

Conditions on I-5 are at LOS A, which represents free flow. The major access roadways in the Area of Analysis that are likely to be affected by Project-related traffic are at LOS A most of the time (Greendot 2016), with occasional delays expected from high recreational traffic on particular days (e.g., Memorial Day, Fourth of July), and seasonal delays from road conditions (e.g., ice and downed trees).

3.22.2.2 Traffic Safety

Road widths, surface materials, vehicle speed limits, etc., are discussed briefly in Section 3.22.2.1 *Traffic Flow*. Additional information in Appendix B: *Definite Plan – Appendix K* includes an evaluation of sight stopping distance, intersection and roadway geometry, and road conditions. Google Earth Street View (2018), as well as county transportation planning documents that discuss road conditions, traffic accident data, etc. (Greendot 2016; Fehrs and Peers 2011) were also incorporated into the evaluation of traffic safety. The delivery of off-road construction equipment, including cranes, large excavators, loaders, and large capacity dump trucks would be by special tractor-trailer vehicles operating under “wide load” restrictions and at appropriate speeds. Intersection and infrastructure field observations are included in Appendix B: *Definite Plan – Appendix K*.

3.22.2.3 Road Conditions

The existing roads in the transportation and traffic Area of Analysis are owned by PacifiCorp, the Federal Government, Siskiyou County or private entities (Figure 3.14-2). PacifiCorp is currently responsible for maintaining approximately 14.5 miles of roads within lands it owns. Transfer of PacifiCorp land, including roads, within the Parcel B lands would be to the State of California or a designated third-party transferee (see also Section 2.7.10 *Land Disposition and Transfer*).

Roads (including bridges and culverts) in the traffic and transportation Area of Analysis have been utilized to provide rural residential and extensive recreational uses. Roadways originally may have been built for the construction and management of the dams and reservoirs and appear to have served adequately for that purpose (see Appendix B: *Definite Plan – Section 7.4 and Appendix K)*. However, the conditions of the roadways at the time that the dam removal activity is proposed are dependent on what road maintenance activities occur between now and then. According to Appendix B: *Definite Plan – Section 7.4 and Appendix K*, several roads (including bridges and culverts) near the Lower Klamath Project dam facilities are currently inadequate (narrow lanes, bridges of varying conditions, culverts that may be undermined). Recent (2017) surveys have identified the roadways, bridges, and culverts that may require improvements over their current conditions in order to withstand construction-related traffic under the Proposed Project. These roadways, bridges, and culverts are listed below.

Road and Bridge Improvements/Replacements

- Copco Road from I-5 to Ager Road—some pavement rehabilitation.
- Copco Road from Ager Road to Lakeview Road—poor condition, some pavement rehabilitation.
- Copco Road Bridge – potential erosion protection to abutments/ pier.

- Dry Creek Bridge—to be replaced, strengthened or provided with a temporary crossing.
- Copco Road between Lakeview Road and Daggett Road—poor condition, some pavement rehabilitation.
- Jenny Creek Bridge—to be replaced post-construction.
- Copco Road from Daggett Road to Copco Access Road—some road surface rehabilitation during construction.
- Fall Creek Bridge—to be replaced.
- Copco Access Road—grading and clearing required.
- Barge Access to Copco Lake—minor access improvements for barge/crane, boat ramp extension.
- Ager Beswick Road—minor access improvements for barge/crane, boat ramp extension at Mallard Cove.
- Daggett Road—some road surface rehabilitation during construction.
- Daggett Road Bridge—to be replaced, strengthened or provided with a temporary crossing.
- Lakeview Road between Copco Road and Disposal Site—some road surface rehabilitation during construction.
- Lakeview Road Bridge—to be replaced, strengthened or provided with a temporary crossing.
- Powerhouse Access Road—some road surface rehabilitation during construction
- Upstream Left Abutment Access Road—to be re-established then reclaimed post-construction.
- Access Road from Long Gulch Recreational Facility to Lakeview Road - some road surface rehabilitation during construction.
- Access Road from Overlook Point Recreational Facility to Copco Road - some road surface rehabilitation during construction.

Culvert Replacements

- Copco Road at Beaver Creek, East Fork Beaver Creek, Raymond Gulch, West Fork Unnamed Creek, Scotch Creek, 200 feet east of Scotch Creek, small cross-culverts between Brush Creek And Scotch Creek, Camp Creek
- Patricia Avenue at East and West Forks Unnamed Creek
- Deer Creek
- Indian Creek
- Daggett Road at Fall Creek

The proposed improvements to existing roads, bridges and culverts to support short-term construction activities are described in more detail in the following Appendix B: *Definite Plan* locations:

- *Sections 5.2.2, 5.3.2, 5.4.2 and 5.5.2* discuss construction access assessments and related transportation improvements and maintenance.
- *Section 7.4 and specifically Table 7.4.1* describes post-construction transportation improvements and maintenance.

- *Appendix K* contains specifics of the road infrastructure assessment.

The KRRC proposes to develop final designs for planned road, bridge, and culvert improvements during the detailed design phase or as part of a contractor bid document for the Proposed Project (Appendix B: *Definite Plan*). Development of final designs would enable agencies that must approve road, bridge, and culvert improvements to determine the necessity and scope of additional environmental review of those improvements.

3.22.2.4 Emergency Access

The location of the Proposed Project is generally rural, with limited access to vehicular emergency services. As such, rural users realize that response times for emergency access are much longer than in more urban settings. Sections 3.21 *Hazards and Hazardous Materials* and 3.17 *Public Services* of this EIR describe the actual service providers and ability to respond; the Traffic and Transportation analysis is limited to accessibility by emergency service vehicles.

Most roads that already experience truck traffic for hauling boat trailers or other large vehicles/equipment are generally adequate for emergency vehicle use, as has occurred in the past. Roads with residences or farms have experienced construction-sized vehicles and equipment for construction and maintenance. Emergency response times are affected by weather, road conditions, and the amount of other traffic using the road system at the same time. Existing limitations on bridge width and conditions may also affect emergency access and response times.

3.22.2.5 Public Transit

Transit Service

Siskiyou Transit and General Express (STAGE) is the county's public transit service provider. STAGE is the only regional service that connects the downtown areas of Dunsmuir, Weed, Mt. Shasta, Grenada, McCloud, Yreka, Montague, Fort Jones, Greenview, Etna, Klamath River, Horse Creek, Hamburg, Seiad Valley, and Happy Camp. See Table 3.22-3 for destination information. Service is very limited, sometimes running only one or two times a week. The Hornbrook route branches into the Area of Analysis for traffic and transportation and, as of 2016, runs twice a week. The Hornbrook route follows I-5 north into Hornbrook, turns east on Copco Road, and then turns south (before reaching Iron Gate Dam) at Ager Road, heading towards Montague.

In addition, Greyhound Lines provides service within the region in Weed, near the College of the Siskiyous. This location is accessible via the STAGE bus transit service. As with STAGE, this service is limited and is along a major U.S. highway.

Table 3.22-3. Siskiyou Transportation and General Express Routes (STAGE).

STAGE Routes	Destinations
Northbound I-5	Dunsmuir, McCloud, Mt. Shasta, Weed, Gazelle, Grenada, Cove Trailer Park, Yreka
Southbound I-5	Yreka, Cove Trailer Park, Grenada, Gazelle, Weed, Mt. Shasta, Dunsmuir
Montague/Scott Valley/Hornbrook	Yreka, Montague, Hornbrook, Scott Valley (Fort Jones, Etna)
Lake Shastina	Weed, Mt. Shasta, Dunsmuir, Lake Shastina
Happy Camp/Orleans	Yreka
Yreka Northbound	Various destinations within Yreka, Karuk
Yreka Southbound	Various destinations within Yreka, Karuk

Source: Greendot 2016

Air Transportation

Siskiyou County operates five public use, general aviation airports: Butte Valley, Happy Camp, Scott Valley, Weed, and Siskiyou County. A private emergency medic flight service operates between Medford, Oregon and Redding, California. In addition, United Parcel Service (UPS) Ground and Air Freight Services are available at the Montague/Yreka Rohrer Field and the Dunsmuir Municipal Airport. Each airport is owned and operated by its respective city. The Siskiyou County Airport, located in Shasta Valley—11 miles east of Yreka—is home to a USDA Forest Service Fire Attack Base in the summer months (Greendot 2016). The closest public airport is Siskiyou County Airport, which is more than 10 miles south of Iron Gate Dam in Montague. No private or public airport or airfield is within two miles of the Proposed Project.

Rail Transportation

The rail line in Siskiyou County has been dormant from Weed to Oregon since 2008, yet remains historically significant. The rail line follows the Sacramento River and I-5 through the California Central Valley, Shasta and Siskiyou Counties, and into Oregon. Recent grants have allowed for rehabilitation and repair projects for sections of the track. Reopening the track will create additional transportation options for lumber and manufacturing goods from Oregon, which will subsequently result in decreased truck use to transport goods. The rail line is an important historic and cultural attraction in Dunsmuir where the rail line is actively used for passenger travel through Amtrak. Near the rail line in Dunsmuir, the Railroad Resort offers a hotel, restaurant, and museum in vintage train cars.

Amtrak provides rail service in Dunsmuir and Klamath Falls; both are stops along the “Coast Starlight” route, which connects Vancouver, BC, to San Diego, CA. Several stations along the “Coast Starlight” route provide a bus and rail connection to Amtrak’s nationwide network. The Dunsmuir Amtrak station is accessible via the STAGE bus transit service.

3.22.2.6 Non-Motorized Transportation

The road system briefly described in Section 3.22.2.1 *Traffic Flow* has a varying but relatively rare amount of non-motorized use compared to motorized use,. However, it is anticipated that there could be occasional non-motorized commute and recreational uses on the thoroughfares and localized use by residents and recreators on local roads close to all three dam facilities. Similar to motorized traffic, non-motorized transportation would be subject to seasonal fluctuations based on weather, occupation of residences, and seasonal activities including resource utilization and school sessions. Other recreational uses such as motorized and non-motorized boating are discussed in Section 3.20 *Recreation*.

3.22.3 Significance Criteria

Criteria for determining significance on transportation and traffic is informed by Appendix G of the CEQA Guidelines (California Code of Regulations, title 14, section 15000 et seq.) and based on professional judgment. Effects on transportation and traffic are considered significant if the Proposed Project would result in one or more of the following:

1. Substantial increase in traffic where substantial is defined as a quantity in excess of the capacity or design of the road improvement or impairs the safety or performance of the circulation system, including transit, roadways, bicycle lanes or pedestrian paths.
2. Substantial conflict with an applicable congestion management program, including, but not limited to LOS and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways that would result in an increased risk of harm to the public.
3. Substantial increase in hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment) that would result in an increased risk of harm to the public.
4. Result in inadequate emergency access that would result in harm to the public.
5. Substantially conflict with public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities that would result in an increased risk of harm to the public.
6. Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks.

3.22.4 Impact Analysis Approach

The approach to impact analysis for transportation and traffic evaluates the existing transportation circulation within the Area of Analysis for comparison with projected circulation under the Proposed Project. The impact analysis for transportation and traffic focuses on short-term construction-related activities, which generally include the pre-construction period, the dam removal period (up to two years), and one to five years after dam removal, where the latter includes the majority of anticipated restoration and monitoring activities (Appendix B: *Definite Plan*). While this section considers the sporadic activities that would occur throughout this period, the transportation and traffic impact analysis focuses on the six-month period during the peak of the construction-related activity, when concurrent activity would occur in the removal of the three California dams and compares this to the summertime peak recreational activity that is currently occurring. Once the construction-related activity is completed there will be no traffic generated directly related to the Proposed Project. Therefore long-term impacts, those occurring after the construction-related activities are completed, were considered to be less than significant when roads and other infrastructure are left in a condition equal or better than pre-project.

The transportation analysis considers the increase in traffic related to these short-term construction activities and the potential conflicts with residents and property owners in the area, as well as any recreational or visitor traffic that may occur during the activity period. This analysis also considers school bus traffic. The majority of the dam removal activity is proposed in May through September (Table 2.7-1), when, for the majority of the time, school is not in session. The transportation analysis considers the capacity and design of the roads used during activity times.

The Proposed Project addresses such factors as traffic management, emergency response, fire management, structural analysis of the integrity of the roads, bridges and culverts and implementation of required improvements prior to and after construction activities (Appendix B: *Definite Plan –Appendix O*). These factors are all an integral part of analyzing the potential for transportation impacts associated with the construction-related activities as well as after the completion of the Proposed Project. Additional related analysis is also found in other sections of the EIR, as listed in Table 3.22-4.

Table 3.22-4. Transportation-related Discussion Found Elsewhere in this EIR.

Transportation Issues	Section No.	Topic(s)
Vehicle Emissions	3.9	Air Quality
Greenhouse Gas Emissions	3.10	Greenhouse Gas Emissions
Community Connectivity	3.14	Land Use and Planning
Emergency Response	3.17	Public Services
Emergency Response	3.21	Hazards and Hazardous Materials

The Siskiyou County Local Transportation Commission (SCLTC) is the designated Regional Transportation Planning Agency for Siskiyou County. The County is within the jurisdictional boundaries of California Department of Transportation (Caltrans) District 2, located in Redding. The SCLTC, along with Caltrans District 2, fulfills the transportation planning responsibilities for Siskiyou County. As noted in the Siskiyou County Regional Transportation Plan the primary local and regional issues continue to revolve around a lack of maintenance funding to maintain the integrity of existing facilities. A major concern for Siskiyou County is the continuing maintenance requirements of the existing road system. Delayed projects and the lack of funding results in additional deterioration of already poor pavement quality, higher costs due to inflation, and more expensive rehabilitation and reconstruction costs. (Greendot 2016). Chapter 3 of the Regional Transportation Plan contains objectives and policies to meet the specified goals in the Regional Transportation Plan. In addition, the major goal and objective of the Land Use and Circulation element of the County's general plan is "to protect the county's critical natural resources and still allow room for adequate growth and development. The Proposed Project would not conflict with the measures set forth in the Regional Transportation Plan or with the goal and objective of the Land Use and Circulation element of the County's general plan. The Regional Transportation Plan does not contain measures or programs that would conflict with the Proposed Project in a manner that would adversely affect the environment.

3.22.5 Potential Impacts and Mitigation

Potential Impact 3.22-1 Proposed construction-related traffic could potentially result in a substantial increase in traffic in excess of the capacity or design of the road improvements or impairs the safety or performance of the circulation system, including transit, roadways, bicycle lanes or pedestrian paths

Potential Impact 3.22-2 Proposed construction-related traffic could potentially conflict with an applicable congestion management program, including, but not limited to, level of service standards and travel demand measures or other standards established by the county congestion management agency for designated roads or highways that would result in increased risk of harm to the public.

The below analysis applies for both Potential Impacts 3.22-1 and 3.22-2.

As described in Section 3.22.2.1 *Traffic Flow*, roadways that would be utilized for dam removal activities are generally narrow, rural roads that have been used primarily for a small amount of residential use and the existing seasonal recreational use demand associated with the reservoirs.

Short-term impacts to local roads would be primarily limited to the pre-construction period, the dam removal period (May through September of the drawdown year; Table 2.7-1) and one to five years after dam removal during restoration and monitoring activities. The pre-construction and dam removal period would include the import and export of materials and equipment, as well as the construction workforce associated with all the elements of the Proposed Project. Dam removal itself would result in the highest projected construction intensity under the Proposed Project, and thus the greatest workforce and number of associated vehicle trips. Table 3.22-5 presents the projected size of the dam removal workforce that would be commuting daily to the site, and the duration of the activity for each of the dams, presented as both an average and a peak value. The size of the construction workforce at each site would vary, and the peak times for construction would be staggered across sites.

Table 3.22-5. Workforce Projections for Dam Removal for the Proposed Project.

Dam	Estimated Construction Workforce	Duration	Estimated Peak Workforce	Peak Period
J.C. Boyle*	30 people	9 months	45 people	Jun−Sep dam removal year 2
Copco No. 1	35 people	12 months	55 people	Apr–Nov dam removal year 2
Copco No. 2	30 people	6 months	40 people	Apr−Sept dam removal year 2
Iron Gate	40 people	10 months	80 people	Jun−Sep dam removal year 2

* J.C. Boyle Dam is included in this analysis as some of the traffic flow may use roads in California (e.g., I-5 to OR 66)
Source: Appendix B: *Definite Plan – Section 5*

Based on Table 3.22-5, the Proposed Project creates the greatest traffic-related impacts due to construction occurring at three or more dam sites simultaneously. For instance, while only the Copco No. 1 Dam is proposed to begin removal activities for the last two months of Year 1, concurrent activity at four dams is projected for six months (April-September) with an average workforce 135 people and peak activity occurring for four months (June-September) with a 220-person peak workforce. If just considering the three California dams, concurrent activity is projected with an average workforce of 105 people and peak activity workforce of 175 people. These numbers would equate to one-way trips to or from the Proposed Project. If construction schedules shift, projections of traffic impacts may also shift, however, there would likely be times of concurrent activities regardless of small shifts in the Proposed Project schedule.

Because recreational facilities at the reservoirs would be closed during the construction period, this analysis assumes that traffic associated with recreational use of the reservoirs would cease during the construction period. When the additional traffic flow from the short-term concurrent activities associated with dam removal is compared to the current traffic flow for recreational use of the reservoirs, the workforce traffic is similar to the current recreational use traffic. FERC (2007) identified the total annual recreational days for both Copco No.1 (8,850 days) and Iron Gate (51,795 days) reservoirs. If the recreational use were to be evenly distributed throughout a year, then there would be a total of 166 "recreational uses," or trips per day, at recreational facilities within the Proposed Project area. There is no information on the peak number of recreational trips from recreational use, however it is likely that recreational use peaks during summer months. If it is assumed that peak recreational trips are double the average, the peak number would be 332 trips per day. Using the more conservative (for the purpose of comparison of effects) assumption that peak recreational trips are 20 percent greater than the average, the peak number would be approximately 199 trips per day. It is also assumed that recreational use peaks between June and September, which coincides with the proposed peak workforce months for construction activity. Based on these assumptions and the average and peak numbers of the construction workforce set forth in Table 3.22-5, traffic flow during the dam removal period would be similar to what occurs currently for recreational uses (166 average trips and 199 peak trips for recreational use, and 105 average and 175 peak trips per day for dam removal). With the closure of reservoir recreational facilities during construction activities, the average number of daily workforce trips is expected to be less than the average daily reservoir-related recreational trips during Project construction.

Recreational use trips associated with recreation at areas within the Area of Analysis other than Copco No. 1 and Iron Gate reservoirs may still occur during construction periods, but because Copco No. 1 and Iron Gate facilities would be closed, it is expected that continued recreational use traffic would be dispersed away from the immediate vicinity of Copco No. 1 and Iron Gate and would not overlap with construction traffic. Additional discussion of alternative recreational opportunities is described in Section 3.20 *Recreation*.

Additionally, under the Proposed Project, estimated vehicle trips for imported materials and waste disposal would generate a short-term increase in traffic volumes (Table 3.22-6). The short-term construction-related import and export of materials and equipment combined with workforce-related vehicle trips added to the existing AADT would be lower than the existing road capacities listed in Table 3.22-2. It is also possible that, depending on the contractors that are selected to undertake the construction work for each of the Lower Klamath Project dams, there may be overlap of work crews and equipment movement between the three California dams and J.C. Boyle Dam in Oregon. Some traffic from J.C. Boyle Dam construction activities may enter California, increasing the number of estimated vehicle trips noted in Table 3.22-6, but any estimate of either of these examples would be speculative.

Table 3.22-6. Vehicle Trips (VT) for the Import/Export of Materials for the Proposed Project*.

Dam	Estimated VT Imported	Estimated VT Exported	Total VT	Peak Duration	VT per Day
Copco No. 1	1,720	706	2,426	7 months	15
Copco No. 2	Included in Copco No. 1 VT estimates	1,928	1,928+	6 months	14
Iron Gate	380	746	1,126	4 months	12
J.C. Boyle	200	1,024	1,224	4 months	13

* VT numbers consider both full and empty returns.
Source: Appendix B: *Definite Plan – Section 5, revised (S. Leonard, AECOM as KRRC Technical Representative, pers. comm., November 2018).*

As noted in Section 3.22.2.1 *Traffic Flow*, the two major roads used for access would be Interstate 5 and Copco Road. Copco Road has an ADT of 485 and a LOS A capacity of 1300 ADT. Adding 391 ADT from both worker trips (350 ADT) and waste movement (41 ADT), Copco Road would remain at a LOS A. Likewise for Interstate 5, with an AADT of 20,900 and LOS A capacity of 25,400 AADT, there is sufficient capacity for added traffic (391 ADT) to keep the LOS level at LOS A. These short-term additional trips would cease after the Proposed Project is completed.

The period between one and five years after dam removal, associated with restoration and monitoring activities, would also involve an increased level of traffic but this would be less than existing recreational traffic and minor in comparison to traffic occurring during pre-construction and dam removal activities.

The long-term effects of the Proposed Project would include a reduction in overall recreational use of the reservoirs and associated traffic, along with the potential for a minor increase in associated traffic for river-associated recreational use, such as river kayaking and fishing. Given the decrease in traffic related to the reduction of reservoir-associated recreational use, the small increase in river-associated recreational use would be less than significant, as discussed in more detail in Section 3.20 *Recreation*.

With the low amount of current residential and recreational uses, the existing roads, bridges and culverts may have served adequately in the past; however, expanded use, such as from proposed construction-related activities related to deconstruction of the dam facilities, though it may be for a short period, would require additional evaluation, according to Appendix B: *Definite Plan – Section 7.4*. Roadways, bridges, and culverts that may require improvements over their current conditions in order to withstand construction-related traffic under the Proposed Project are listed in Section 3.22.2.3 *Road Conditions*. The Proposed Project would include improvement of these facilities to a level that would enable them to accommodate traffic associated with the Proposed Project without being degraded below baseline conditions. Final designs for planned improvements would be developed during the detailed design phase or as part of a contractor bid document for the Proposed Project, and would inform decisionmakers regarding the necessity and scope of additional environmental review. In addition, the discussion of impacts and mitigation measures set forth in this EIR, including Mitigation Measures WQ-1, TER-1, TER-2, TER-3, TCR-1, TCR-2, TCR-3, TCR-4, and HZ-1, would assist those decisionmakers in determining how the impacts of road improvements can be mitigated.

Finally, as noted above, the Proposed Project would not conflict with the measures set forth in the Regional Transportation Plan or with the goal and objective of the Land Use and Circulation element of the County's general plan does not contain measures or programs that would conflict with the Proposed Project in a manner that would adversely affect the environment.

Overall, additional traffic related to pre-construction activities, dam removal, waste transportation, restoration and monitoring activities, and planned improvements to existing roads, bridges and culverts under the Proposed Project would replace, and be similar to existing recreational use levels and thus would not have substantial, short-term impacts on the LOS in the Area of Analysis. However the proposed activities could result in impairing the safety or performance of the circulation system for all users, resulting in a potentially substantial risk of harm to the public.

The Proposed Project includes a draft Traffic Management Plan (Traffic Management Plan) that identifies the key requirements that would be incorporated by the construction contractor into a final Traffic Management Plan. According to Appendix B: *Definite Plan – Appendix O2*, the Traffic Management Plan is a specialized program tailored to minimize impacts by applying a variety of techniques such as *Public Information, Motorist Information, Incident Management and Construction Strategies.* The major objectives of the Traffic Management Plan are to maintain efficient and safe movement of vehicles through the construction zone covered by activities in the Definite Plan and to provide public awareness of potential impacts to traffic on both haul routes and access roads to the four dam complexes. The Traffic Management Plan outlines the structure and key requirements that would be incorporated by the KRRC's contractor into a final Traffic Management Plan. The final Traffic Management Plan would be informed by KRRC's contractor's specific means and methods for construction, which could refine the approach to access and traffic management. KRRC proposes that the final Traffic Management Plan would meet applicable regulatory permit requirements, as well as applicable state and local ordinances, as appropriate. In addition, as described in Potential Impact 3.22-4, KRRC will also be finalizing an Emergency Response Plan, which is integrally related to the Traffic Management Plan. As such these two plans are discussed together below.

The Traffic Management Plan would be further developed by KRRC working with the appropriate agencies through the FERC process. Additional details to be added to the final Traffic Management Plan and Emergency Response Plan would include those items listed in the draft Traffic Management Plan and Emergency Response Plan (Appendix B: Definite Plan – Appendix O2 and O4). KRRC also proposes that KRRC and the appropriate state and local agencies would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be "good citizens" of the communities in which projects are located and thus to comply, where possible, with state and local requirements.

It would be appropriate for the recommended terms and conditions relating to traffic and transportation in the final Traffic Management Plan and Emergency Response Plan to provide implementation details consistent with all applicable regulatory permit requirements including the latest version of the Caltrans California Manual on Uniform Traffic Control Devices (Caltrans 2018b) and be coordinated with the noted agencies (Caltrans, Siskiyou County, California Highway Patrol, CALFIRE, and other emergency response agencies) as part of the detailed design phase and prior to start of construction. Recommended Measure TR-1 includes additional and feasible components beyond those listed as part of the Proposed Project that would reduce potential short-term construction-related impacts on performance of the circulation system and congestion. However, overseeing development and implementation of the final Traffic Management Plan and Emergency Response Plan does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to reach enforceable "good citizen" agreements that will be finalized and implemented, at this time the Traffic Management Plan and Emergency Response Plan are not finalized and the State Water Board cannot require their implementation. Accordingly, the State Water Board anticipates that implementation of the final Traffic Management Plan and Emergency Response Plan, including the aforementioned additional details and any modifications developed through the FERC process that provide the same or better level of protection for transportation and traffic, would be expected to ensure that impacts are lowered to less than significant. Because the State Water Board cannot ensure the Traffic Management Plan's and Emergency Response Plan's implementation, it has determined the impact in this Draft EIR to be significant and unavoidable.

Recommended Measure TR-1 – Transportation and Traffic.

A. The KRRC and/or its contractor(s) shall develop a final Traffic Management Plan that provides:

1. Implementation details consistent with all applicable regulatory requirements including the latest version of the Caltrans California Manual on Uniform Traffic Control Devices (Caltrans 2018b) and coordination with the noted agencies (Caltrans, Siskiyou County Public Works and Sheriff's Departments, California Highway Patrol, CALFIRE, and other emergency response agencies) as part of the detailed design phase and prior to start of construction. Potential conflicts with bicycle and pedestrian use, as well as transit and school bus service, need to be addressed in the Traffic Management Plan. The final version of the Traffic Management Plan, after coordination with the above referenced agencies, shall be received by the State Water Board prior to the start of construction.
2. Each road, bridge, and culvert improvement project included in the Proposed Project, or any other road, bridge, or culvert improvement project that is identified as necessary for the Proposed Project, shall be constructed consistent with the latest version of the Caltrans Highway Design Manual (Caltrans 2018c) or equivalent, and shall not conflict with any applicable plan, ordinance, or policy regarding performance of the transportation system, traffic safety and/or congestion management within the Area of Analysis. Construction shall not begin until all final designs for road, bridge, and culvert improvement projects included in the Proposed Project have been received and approved, as necessary, by the county and other responsible agencies.
3. The KRRC shall be responsible for repairing and/or rehabilitating any Siskiyou County roadways within the traffic and transportation Area of Analysis that are damaged or otherwise adversely impacted by Proposed

Project activities, such that they are in a condition equal to or better than they were before dam removal activities.

B. The KRRC and/or its construction contractor(s) shall develop an Emergency Response Plan with details and procedures to be put in place to help prevent incidents, to ensure preparedness in the event incidents occur, and to provide a systematic and orderly response to emergencies through coordination with emergency response agencies, as described in Appendix B: *Definite Plan − Appendix O4*.

Significance

Significant and unavoidable impact

Potential Impact 3.22-3 Proposed construction-related traffic could result in substantially increasing hazards due to a design feature (e.g., sharp curves or narrow lanes) or incompatible uses (e.g., oversized construction equipment) that would result in an increased risk of harm to the public.

Roads, bridges, and culverts in the transportation and traffic Area of Analysis currently serve rural residential and extensive recreational uses (Section 3.22.2.3 *Road Conditions*). Some of the roadways originally may have been built for the construction of the Lower Klamath Project dams and appear to have served adequately for that purpose. However, the existing conditions of the roadways and other infrastructure are not adequate for all of the construction activities included in the Proposed Project, as described in Appendix B: *Definite Plan − Appendix K*. As described in Impacts 3.22-1 and 3.22.-2, the improvements may include five bridges (two of them over the Klamath River) that need to be replaced: four bridges for construction purposes, and one bridge post-construction because it is built on reservoir sediment. There are 13 or more culverts that need replacement. As described in Appendix B: *Definite Plan − Appendix K,* there are portions of 20.3 miles of road that would need partial road improvements. Some descriptions note that sections of roads are in poor condition but no improvements are proposed. These sections of roads may not be up to a standard for the transportation of construction equipment, adequate for emergency response, or in a condition adequate for future use after dam removal activities have been completed.

The Proposed Project includes general information regarding planned improvements to existing roads, bridges, and culverts to support short-term construction activities. While the general information suggests that none of the road, bridge, and culvert improvement projects would substantially increase traffic or transportation hazards due to a design feature or incompatible use, it notes that details of each improvement would be developed during the detailed design phase or as part of a contractor bid document for the Proposed Project (Appendix B: *Definite Plan*). The draft Traffic Management Plan (Appendix B: *Definite Plan − Appendix O2*) further notes that the KRRC's contractor would perform a risk assessment of all intersections and roadways as part of the final Traffic Management Plan.

Implementation of Recommended Measure TR-1 would require additional components beyond those listed as part of the Proposed Project (i.e., the final versions of the Traffic Management Plan and Emergency Response Plan) and these components would be necessary to reduce potential traffic and transportation hazards due to a design feature or incompatible uses to less than significant. Overseeing development and implementation of the final Traffic Management Plan and Emergency Response Plan, including measures described in Recommended Measure TR-1, does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to reach enforceable "good citizen" agreements that will be finalized and implemented, at this time the Traffic Management Plan and Emergency Response Plan are not finalized and the State Water Board cannot require their implementation. Accordingly, the State Water Board anticipates that implementation of the final Traffic Management Plan and Emergency Response Plan, including the aforementioned additional details in Recommended Measure TR-1 and any modifications developed through the FERC process that provide the same or better level of protection for transportation and traffic would be expected to ensure that impacts to less than significant. However, because the State Water Board cannot ensure implementation of the final Traffic Management Plan and Emergency Response Plan, it has determined the impact in this Draft EIR to be significant and unavoidable**.**

Significance

Significant and unavoidable impact

Potential Impact 3.22-4 The Proposed Project could result in inadequate emergency access that would result in harm to the public.

The analysis of adequate emergency response considers the needs for emergency access related to dam removal activities, as well as concurrent emergency access for residents and property owners in the area. An example of inadequate emergency access would be a delay that might occur from a fire truck traveling in the opposite direction of large construction equipment, or an ambulance responding to a traffic accident at the time that construction workers are traveling to the work site.

Under the Proposed Project, the types of emergency vehicles would be similar to the types of vehicles currently using roadways, and the construction activities and schedule (Table 2.7-1) would provide a similar degree, but different type, of vehicular traffic within the Area of Analysis that is beyond current traffic levels and types. The peak of construction-related traffic would generally be for a two-year period (Table 2.7-1). Changes to traffic types and patterns could increase the potential for traffic-related conflicts due to the Proposed Project (e.g., construction-related traffic) as well as other users of the road, whether they be residents, or motorized and non-motorized transportation users. (However, as described under Section 3.22.5 above, it is assumed that recreation-related trips would effectively be replaced by construction worker trips during the construction period, which helps to limit traffic increases resulting from the Proposed Project.) Changes in the level of traffic and types of traffic-related conflicts may affect both the response time and the frequency of calls requiring emergency response.

The Proposed Project includes an Emergency Response Plan that addresses transportation-related emergency concerns (e.g., emergency access and response), while a final Emergency Response Plan, with additional details, would be required from the construction contractor (Appendix B: *Definite Plan − Appendix O4*). The Proposed Project considers how emergency access and response would be provided during the time of construction activity and how it would be coordinated with the contractor's Health and Safety Plan, Spill Prevention and Response Plan and Fire Management Plan. (Appendix B: *Definite Plan − Appendices O1 through O4*.) Emergency response is also discussed in Section 3.17 *Public Services* and Section 3.21 *Hazards and Hazardous Materials*, which address impacts related to emergency response providers as well as the risk of increased hazards such as wildfires and adequate access for abating wildland fires. Implementation of Recommended Measure TR-1 would require additional details and procedures to be put in place to help prevent incidents, to ensure preparedness in the event incidents occur, and to provide a systematic and orderly response to emergencies through coordination with emergency response agencies, as described in Appendix B: *Definite Plan − Appendix O4*, which would render potential traffic and transportation impacts of the Proposed Project to levels similar to baseline conditions. However, because wildfires can spread at a rapid speed and involve high risks, any amount of additional response time compared with existing conditions could result in a substantial increased risk of loss, injury, or death involving wildland fires and this would be a significant impact.

Overseeing development and implementation of the final Emergency Response Plan, including the aforementioned additional details in Recommended Measure TR-1, does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to reach enforceable "good citizen" agreements that will be finalized and implemented, at this time the Emergency Response Plan is not finalized and the State Water Board cannot require its implementation. Accordingly, the State Water Board anticipates that implementation of the final Emergency Response Plan, including the aforementioned additional details in Recommended Measure TR-1 and any modifications developed through the FERC process that provide the same or better level of protection for transportation and traffic, would reduce impacts to less than significant. Since the State Water Board cannot ensure the Emergency Response Plan's implementation, it has determined the impact in this Draft EIR to be significant and unavoidable.

Significance

Significant and unavoidable impact

Potential Impact 3.22-5 Construction-related activities could potentially substantially conflict with public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities resulting in an increased risk of harm to the public.

Short-term impacts to public transit, bicycle, or pedestrian facilities would result in an increased risk of harm to the public if construction-related activities substantially decrease the safety of such uses utilizing the roadways within the Area of Analysis. The Proposed Project includes measures to minimize both vehicular and non-vehicular transportation-related conflicts through a Traffic Management Plan (as analyzed in Potential Impact 3.22-1 and 3.22-2). As described in Section 3.22.2.5 *Public Transit*, there is minimal public transit, including bus service, rail service, or airports in the Area of Analysis. Construction-related traffic conflicts could occur where there is an occasional bicyclist or pedestrian using the roadways or when public transportation, including school bus traffic, is using the same roads as construction-related traffic. There is no information available on existing pedestrian or bicycle facilities. A review of Google Earth and Street View (2018) indicated the general absence of sidewalks and bike paths, and no information is available on the amount of bicycle or pedestrian use. Bicyclist or pedestrian use would be subject to a decrease in the performance and safety of the roadways utilized by the Proposed Project during construction activities, resulting in a potentially substantial increased risk of harm to the public, which would be a significant impact.

The Proposed Project includes management strategies in the draft Traffic Management Plan that would identify areas where pedestrians and cyclists could potentially share roads with construction vehicles. KRRC's contractor will install appropriate signage to notify both construction vehicle drivers and non-motorized users of each other's potential presence on the roads. If an unacceptable level of risk to non-motorized users is deemed to persist, KRRC's contractor will arrange appropriate detours to allow continued movement for such users (Appendix B: Definite Plan – Appendix O2). The Traffic Management Plan would be further developed by KRRC working with the appropriate agencies through the FERC process. KRRC also proposes that KRRC and the appropriate state and local agencies would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be "good citizens" of the communities in which projects are located and thus to comply, where possible, with state and local requirements.

It would be appropriate for the recommended terms and conditions relating to traffic and transportation to include Recommended Measure TR-1 as part of the detailed design phase and prior to start of construction. Recommended Measure TR-1 includes additional components beyond those listed as part of the Proposed Project and would ensure that potential short-term construction-related impacts on the safety of all users of the roadways within the Area of Analysis would be less than significant.

Overseeing development and implementation of the final Traffic Management Plan does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to reach enforceable "good citizen" agreements that will be finalized and implemented, at this time the Traffic Management Plan is not finalized and the State Water Board cannot require its implementation. Accordingly, the State Water Board anticipates that implementation of the final Traffic Management Plan, including any modifications developed through the FERC process that provide the same or better level of protection for Transportation and Traffic resource would reduce impacts to less than significant. However, because the State Water Board cannot ensure the Traffic Management Plan's implementation, it has determined the impact in this Draft EIR to be significant and unavoidable.

Significance

Significant and unavoidable impact

Potential Impact 3.22-6 The Proposed Project would not potentially result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks.

Impacts to air traffic could result if the Proposed Project requires a change in flight paths or an increase in flights, resulting in substantial safety risks. There are no airports within two miles of the work area or that would be affected by the Proposed Project. The location of the Proposed Project (away from existing airports) and the short-term duration of construction activities, would not require a change in flight paths or an increase in flights that would result in substantial safety risks. Helicopters may be used for hydroseeding during restoration activities or in response to an emergency (medical, fire), but this would not alter air traffic patterns at any nearby airport. As a result there would be no significant impact.

Significance

No significant impact

3.22.6 References

Caltrans (California Department of Transportation). 2018a. Traffic Census Program. Available at: http://traffic-counts.dot.ca.gov/index.htm. [Accessed December 11, 2018].

Caltrans. 2018b. California Manual on Uniform Traffic Control Devices (CA MUTCD, 2014, Revision 3 (2018). Available at: http://www.dot.ca.gov/trafficops/camutcd/ . [Accessed December 11, 2018].

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Greendot. 2016. Siskiyou County Local Transportation Commission 2016 Regional Transportation Plan. Available at: https://www.co.siskiyou.ca.us/sites/default/files/docs/Siskiyou%20County%20RTP%202016%20Final%20Report%20w-Amend%201%20-%20042017_1.pdf [Accessed December 2018].

3.23 Noise

This section focuses on potential noise- and vibration-related impacts from implementing the Proposed Project. The State Water Board did not receive comments related to noise during the NOP public scoping process (Appendix A).

3.23.1 Area of Analysis

The Area of Analysis for noise and vibration effects associated with the Proposed Project includes areas in the vicinity of Copco No. 1, Copco No. 2, and Iron Gate reservoirs and along the haul routes in Siskiyou County, California (Figures 3.23-1 and 3.23-2). The Area of Analysis includes locations where there is a potential for noise and vibration impacts on sensitive receptors from construction, waste transportation, and construction worker commutes.

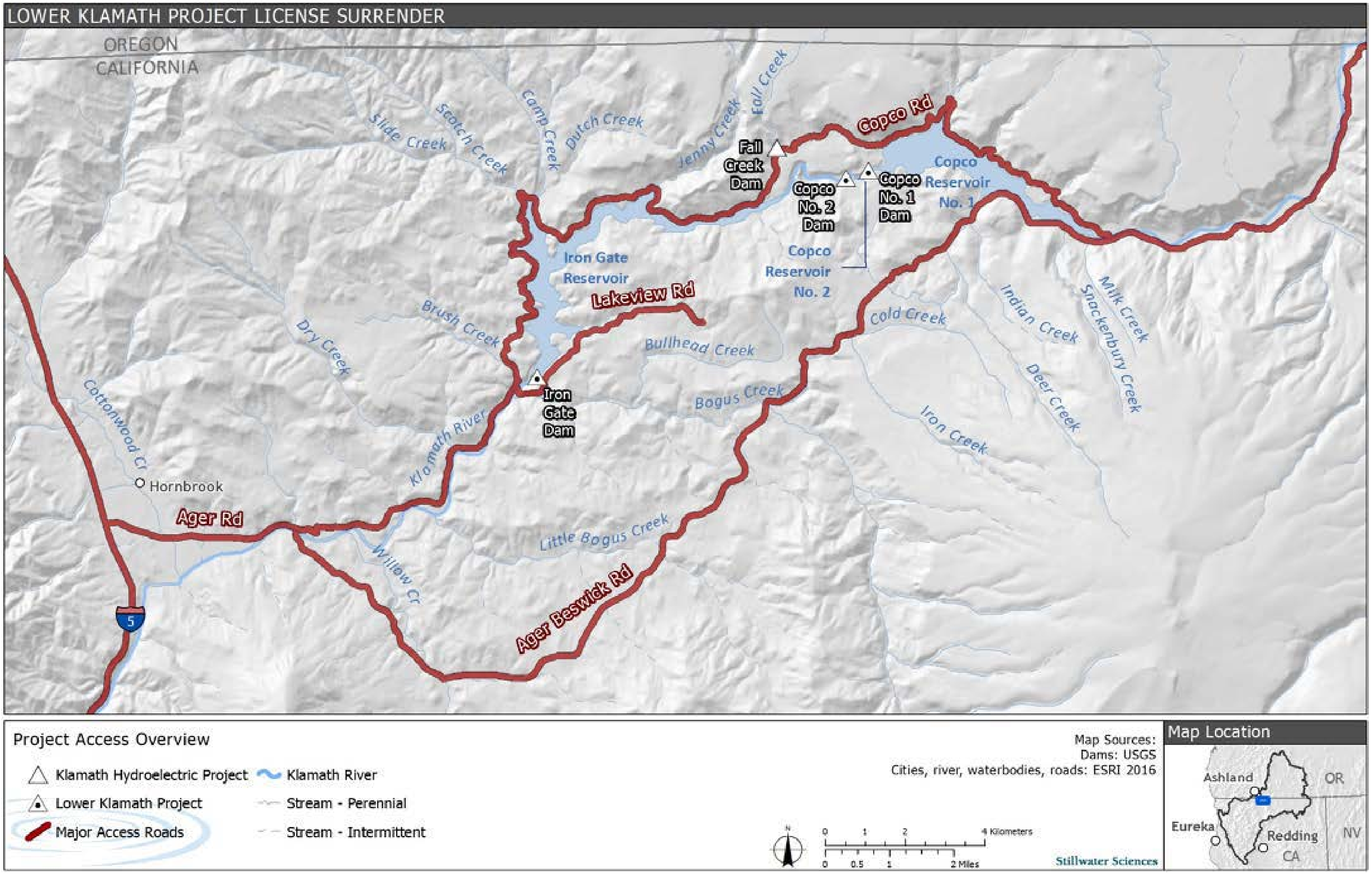

Figure 3.23-1. Proposed Project Access Overview.

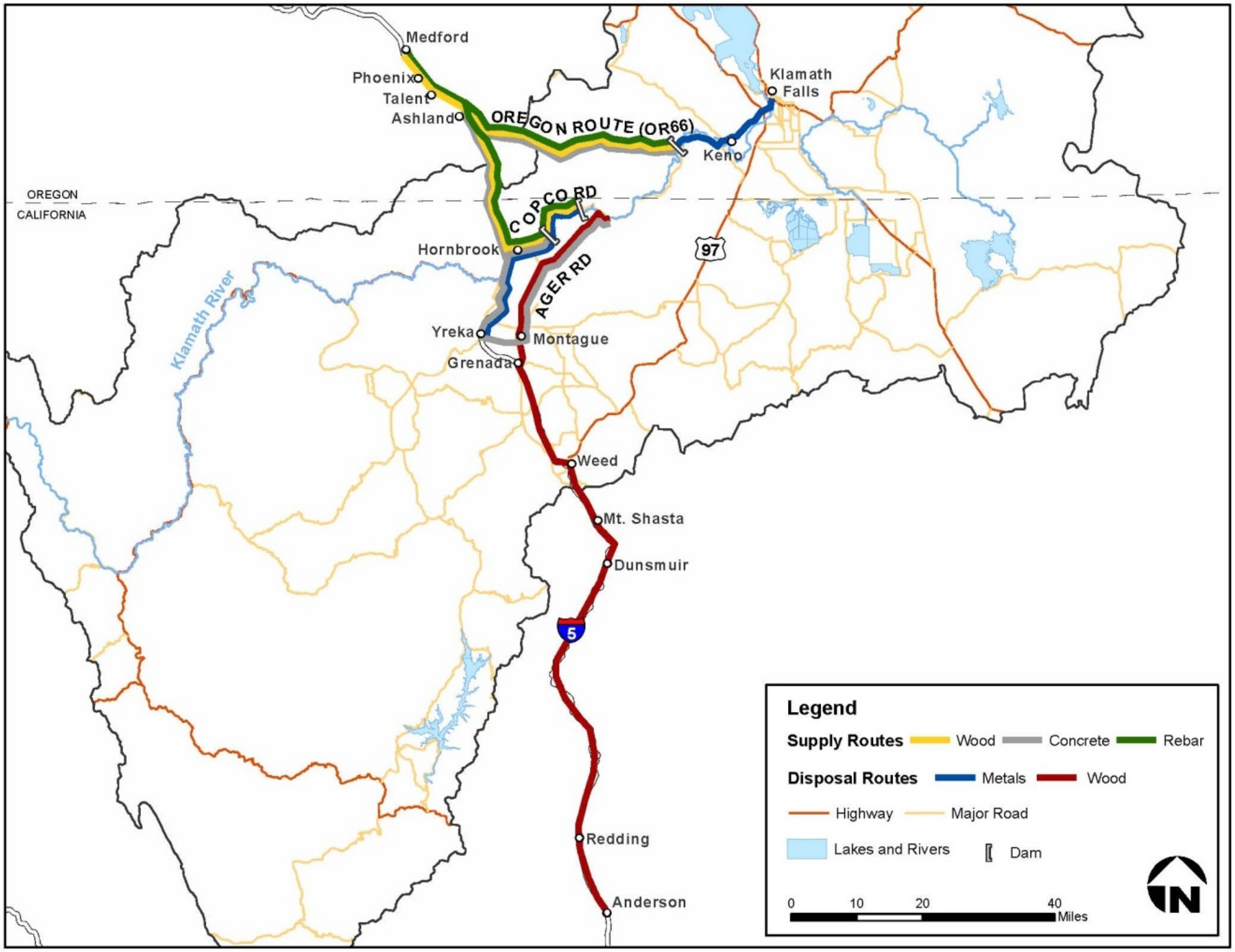

Figure 3.23-2. Primary Haul Routes from Lower Klamath Project Dam Sites.

3.23.2 Environmental Setting

This section provides a description of the environmental setting for noise and vibration in the Area of Analysis, including a brief overview of existing noise conditions in the Klamath Basin to set the stage for subsequent impact analyses.

3.23.2.1 Noise Characteristics

Excessive human exposure to noise can result in adverse physical and psychological responses (hearing loss and other health effects, anger and frustration); can interfere with sleep, speech, and concentration; or can diminish the quality of life. The perceived loudness of sounds depends on many factors, including sound pressure level and frequency content. Sound pressure level is recorded in decibels (dB). While the threshold of human hearing (near-total silence) is approximately zero dB, in typical noisy environments, the healthy human ear generally does not perceive noise-level changes of one to two dB; however, people can begin to detect three dB increases in noise levels. An increase of 5 dB is generally perceived as distinctly noticeable, and a 10-dB increase generally is perceived as a doubling of loudness.

A doubling of sound energy corresponds to an increase of three dB. In other words, when two sources at a given location are each producing sound of the same loudness, the resulting sound level at a given distance from that location is approximately three dB higher than the sound level produced by only one of the sources. For example, if one automobile produces a sound pressure level of 70 dB when it passes an observer, two cars passing simultaneously do not produce 140 dB; rather, they combine to produce 73 dB.

The perception of loudness is generally predictable and can be approximated through frequency filtering, using the standardized A-weighting network, or A-scale (expressed as dBA). The A-weighting approximates the frequency response of the average young ear when listening to most everyday sounds. When people make relative judgments of the loudness or annoyance of a sound, their judgments correlate well with the A-weighting sound levels of those sounds (California Department of Transportation [Caltrans] 2013). All noise levels reported in this analysis are in terms of A-weighting.

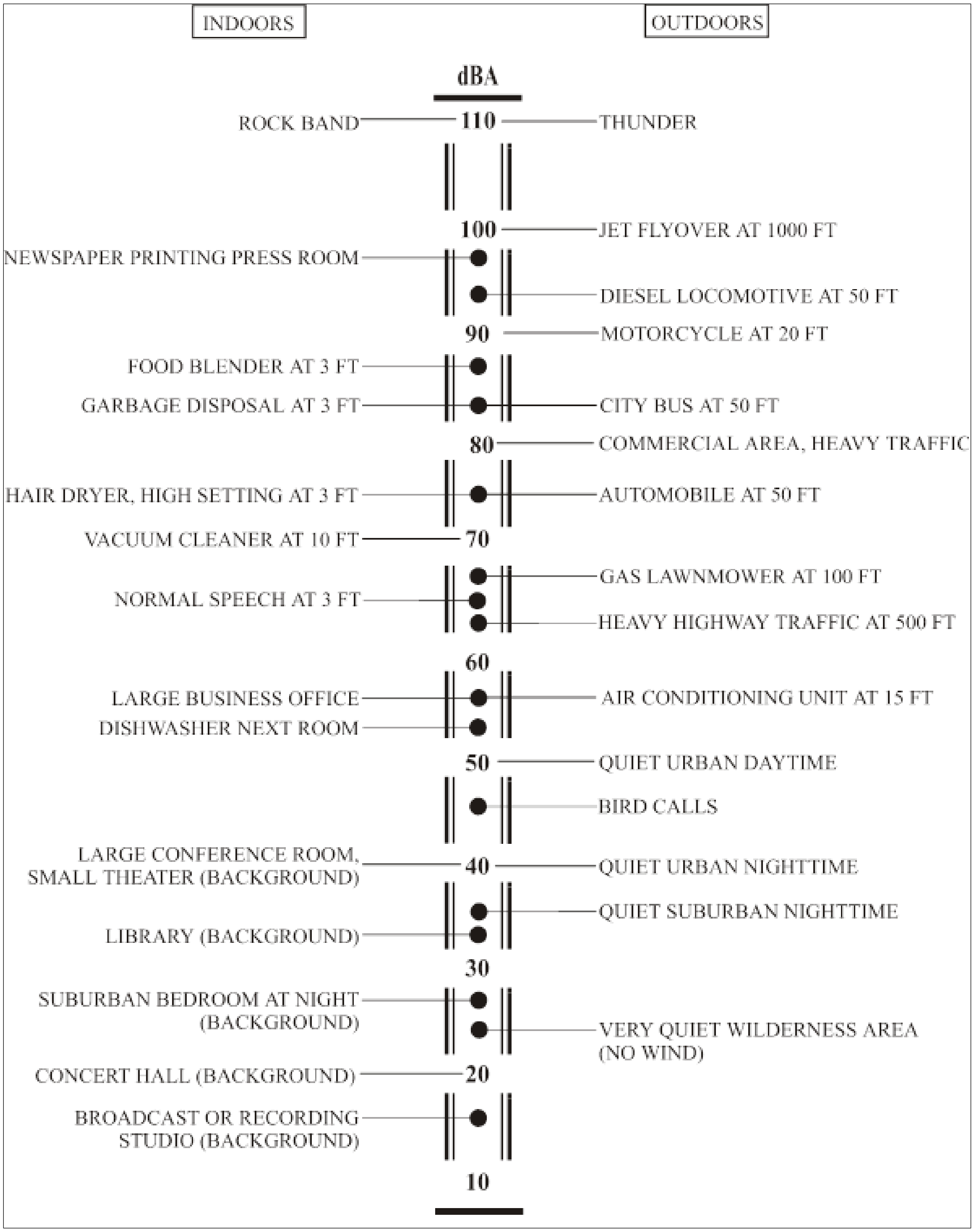

Figure 3.23-3. Decibel Scale and Common Noise Sources. Source: Caltrans 2013.

The following are the sound level descriptors commonly used and incorporated into this environmental noise analysis:

- Equivalent sound level (L_{eq}): An average of the sound energy occurring over a specified time period. In effect, the L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The one-hour, A-weighted equivalent sound level (L_{eq}[h]) is the energy average of A-weighted sound levels occurring during a one-hour period.

- Peak hour L_{eq}: The L_{eq} during the hour with the highest L_{eq}.
- Maximum sound level (L_{max}): The highest instantaneous sound level measured during a specified period.

Sound from a localized source (i.e., point source) expands (propagates) uniformly outward from the source in a spherical pattern. The sound level attenuates due to the following factors (Caltrans 2013):

- Distance between source and receptor;
- Atmospheric effects and refraction;
- Ground absorption;
- Terrain (shielding by natural and manmade features, noise barriers, diffraction, and reflection).

Generally, sound levels attenuate at a rate of six dB for each doubling of distance from a point source (FHWA 2011). Sound from non-point “line” sources (roadways and highways) attenuates at a rate of three dB for each doubling of distance from the linear source.

3.23.2.2 Existing Noise Conditions

Noise-sensitive receptor locations (e.g., rural residences, schools, hospitals, rest homes, churches, long-term care facilities, mental care facilities, residences, convalescent nursing homes, hotels, certain parks) were identified within the Area of Analysis for noise and vibration based on a review of current topographic, aerial, and land use maps. Existing conditions ambient noise levels were identified for both daytime and nighttime. To estimate ambient noise levels at selected receptor locations, the average daytime L_{eq} and nighttime outdoor L_{eq} noise levels from the USEPA’s *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (USEPA 1974) were used. Daytime is defined as the hours between 7:00 a.m. and 10:00 p.m. and nighttime is defined as the hours between 10:00 p.m. and 7:00 a.m. (USEPA 1974). Noise levels for rural residential areas in the USEPA document are lower than the levels presented in the Siskiyou County General Plan (Siskiyou County 1978); thus, it is more conservative to analyze the impacts using the USEPA levels. The following describe the ambient noise and existing sensitive receptors near Copco No. 1, Copco No. 2, and Iron Gate dams.

Copco No. 1 Dam and Associated Facilities

Ambient Noise Condition

The closest noise-sensitive receptor to Copco No. 1 Dam and powerhouse is the Janice Avenue rural residential area, located approximately 2,200 feet to the east of Copco No. 1 Dam (Figure 3.23-5). The estimated existing daytime and nighttime outdoor L_{eq} at the Janice Avenue rural residential area are 40 and 30 dBA, respectively (USEPA 1974) (Table 3.23-1).

Figure 3.23-4. Copco 1 and 2 Noise Receptor (Closest Receptor to Copco No. 1 and Copco 2 No. Dams).

Table 3.23-1. Existing Noise Levels at Residential Receptors near Construction Sites.

Construction Site	Nearest Receptor Description[1]	Distance from Construction Site (feet)	Estimated Existing Daytime L_{eq} (dBA)[2]	Estimated Existing Nighttime L_{eq} (dBA)[2]
Copco No. 1 Dam	Residential Area on Janice Ave, east of Copco No. 1 Dam	2,200	40	30
Copco No. 2 Dam	Residential Area on Janice Ave, east of Copco No. 1 Dam	3,700	40	30
Iron Gate Dam	Residential Area on Tarpon Drive, southwest of Iron Gate Dam	4,500	40	30

Notes:
[1] Source: Google Maps 2018
[2] Source: USEPA 1974
Key:
dBA = A-weighted decibels
L_{eq} = one-hour equivalent noise level

Existing Roadway Traffic Noise

Existing roadway traffic noise is present along Copco Road and Ager-Beswick Road, which are the proposed main off-site haul routes from the Copco No. 1 Dam and powerhouse construction site (Figure 3.23-1). The existing peak hour L_{eq} for the Proposed Project haul routes at 50 feet and 500 feet from the edge of the roadway is summarized in Table 3.23-2.

The existing roadway traffic noise is based on the following information. Peak daytime hour noise level results from Traffic Noise Model, Version 2.5 (TNM2.5) were used for generic receptors located 50 and 500 feet from the edge of the road (50 feet represents the minimum distance for a receptor along any roadway, and 500 feet is the maximum recommended receptor distance for traffic noise models) (Caltrans 2013). Also, field observations conducted in 2012 provided the basis for estimating existing 1-hr L_{eq} along Copco Road and Ager-Beswick Road. In 2012, the Federal Highway Administration (FHWA) TNM2.5 was used to estimate the existing daytime peak hour L_{eq}s along proposed haul routes (Appendix T). Peak-hour traffic was estimated by multiplying the average daily traffic by 10 percent based on a review of Caltrans 2009 average daily and peak hourly traffic data (Caltrans 2009). Average daily traffic values published by Caltrans (2009) were used to estimate the existing noise levels on Interstate 5 (I-5).

Table 3.23-2. Existing Daytime Peak Hour Leq along Proposed Haul and Commute Routes.

Haul Route/Commute Segment	Existing Daytime Peak hour Leq (dBA)[1]	
	50 feet	500 feet
Ager-Beswick Road	53	42
Copco Road	58	46
I-5 between OR-66 and Yreka	76	66

Notes:
[1] Daytime one-hour L_{eq} estimated by modeling traffic counts using TNM2.5 (Appendix T).
dBA = A-weighted decibels
L_{eq} = one-hour equivalent noise level
Sources: Caltrans 2009, ODOT 2010, USEPA 1974, Appendix T

Copco No. 2 Dam and Associated Facilities

Ambient Noise Condition

The closest sensitive receptor to Copco No. 2 Dam is the residential area on Janice Avenue described above for Copco No. 1 Dam (Figure 3.23-5). The receptor is approximately 3,700 feet to the east of Copco No. 2 Dam. The estimated existing daytime and nighttime outdoor L_{eq} at the residences on Janice Avenue, based on the USEPA information, are 40 and 30 dBA, respectively (USEPA 1974) (Table 3.23-1).

Existing Roadway Traffic Noise

Copco Road and Ager-Beswick Road are the proposed main off-site haul routes from the Copco No. 2 dam construction site (Figure 3.23-1). The existing peak hour L_{eq} for the Proposed Project haul routes at 50 feet and 500 feet from the edge of the roadway is summarized in Table 3.23-2. The existing roadway traffic noise is based on the same information as described for Copco No. 1 Dam facilities.

Iron Gate Dam and Associated Facilities

Ambient Noise Condition

The closest sensitive receptor to Iron Gate Dam is the fish hatchery complex (which includes staff residences as well as egg incubation, rearing, maintenance, and administration facilities), located approximately 1,200 feet downstream (Figure 3.23-6). However, PacifiCorp's residential properties, including the staff residences at the hatchery complex, would be unoccupied during Proposed Project construction activities and thus are not considered as a sensitive receptor for the purposes of this analysis. The next closest sensitive receptor to Iron Gate Dam is the rural residential land on Tarpon Drive, approximately 4,500 feet southwest of the dam, as shown on Figure 3.23-6. Based on the rural residential land use category, the existing daytime outdoor L_{eq} on Tarpon Drive likely is 40 dBA and the existing nighttime outdoor L_{eq} at this receptor is approximately 30 dBA (USEPA 1974) (Table 3.23-1).

Figure 3.23-5. Iron Gate Noise Receptors (Closest Sensitive Receptor to Iron Gate Dam).

Existing Roadway Traffic Noise

Existing traffic noise is assessed along Copco Road, located approximately 1,100 feet from Iron Gate Dam, as it would be the main off-site haul route from the Iron Gate Dam and powerhouse construction site (Figure 3.23-1). The existing peak hour L_{eq} for the Proposed Project haul routes at 50 feet and 500 feet from the edge of the roadway is summarized in Table 3.23-2. The existing roadway traffic noise is based on the same information as described for Copco No. 1 Dam facilities.

3.23.2.3 Airport Noise Levels

Siskiyou County owns four airports—in Weed, Fort Jones, Montague, and Dorris. The closest public airport to the Lower Klamath Project is Siskiyou County Airport in Montague, California, which is more than 10 miles south of Iron Gate Dam. No private or public airport or airfield is within two miles of the Lower Klamath Project. Airplanes and helicopters are proposed to be used during seeding as part of reservoir restoration activities (Section 2.7.4 *Restoration Within the Reservoir Footprint*), which would involve airport use. However, the airports themselves are not within the Proposed Project's Area of Analysis.

3.23.3 Significance Criteria

Significance criteria used for the determination of noise and vibration impacts are based on Appendix G of the CEQA Guidelines (California Code of Regulations title 14, section 15000 et seq.) and professional judgement. Noise and vibration effects are considered significant if the Proposed Project would result in one or more of the following conditions or situations:

- Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;
- Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels;
- A substantial permanent increase in ambient noise levels in the Area of Analysis above levels existing without the Proposed Project; or
- A substantial short-term or periodic increase in ambient noise levels in the Area of Analysis above levels existing without the Proposed Project.

This section focuses on noise- and vibration-related impacts to humans. Construction-related noise disturbance and physical vibration (e.g., blasting and use of construction equipment) impacts on wildlife are addressed in Section 3.5 *Terrestrial Resources*.

3.23.3.1 Thresholds of Significance

Noise and vibration levels in the Area of Analysis are regulated by the Siskiyou County General Plan Noise Element (Siskiyou County 1978), which contains criteria for maximum allowable noise levels from construction equipment (Table 3.23-3). There are no other applicable federal, state, or local regulatory levels for noise or vibration in the Area of Analysis.

Table 3.23-3. Siskiyou County General Plan Maximum Allowable Noise Levels from Construction Equipment.

Equipment Type	Peak Noise Level at 100 feet (dBA)	Peak Noise Level at 50 feet (dBA)[1]
Earthmoving		
Front Loaders	75	81
Backhoes	75	81
Dozers	75	81
Tractors	75	81
Scrapers	80	86
Graders	75	81
Trucks	75	81
Pavers	80	86
Materials Handling		
Concrete Mixers	75	81
Concrete Pumps	75	81
Cranes	75	81
Derricks	75	81
Stationary		
Pumps	75	81
Generators	75	81
Compressors	75	81
Impact		
Pile Drivers	95	101
Jackhammers	75	81
Rock Drills	80	86
Pneumatic Tools	80	86
Other		
Saws	75	81
Vibrators	75	81

Source: Siskiyou County 1978

[1] Maximum allowable noise levels from construction equipment at 100 feet from Siskiyou County's General Plan were converted to noise levels at 50 feet (by adding 6 dBA to account for the halving of distance).

Noise

Although the Proposed Project does not involve highway construction, federal and state highway traffic noise criteria provide a basis for analyzing traffic noise impacts. The FHWA requires highway agencies to define a "substantial" noise increase as an increase of 5 to 15 dBA over existing noise levels (23 CFR Part 772). Caltrans defines a "substantial" increase in noise levels from traffic as a predicted increase greater than or equal to 12 dBA at the receptor over existing 1-hour equivalent noise levels (L_{eq}) (Caltrans 2006).

For the purpose of this analysis, an action would be significant if it resulted in any the following:

- Use of construction equipment that exceeds Siskiyou County maximum allowable noise levels from construction equipment; or
- A greater than 10 dBA increase in the daytime or nighttime outdoor one-hour L_{eq} at the receptor from onsite construction operations; or

- A greater than 12 dBA (in California) increase above existing one-hour L_{eq} for traffic-related noise.

The criteria above were based on the characteristics of noise, published studies on vibration effects, and established regulations.

Vibration

Vibration from construction projects is caused by general equipment operations, and is usually highest during pile driving, soil compacting, jack hammering, demolition, and blasting activities. A PPV of 0.3 in/sec or greater can damage old residential structures from continuous or frequent vibration sources (Jones and Stokes 2004). The annoyance level for vibration is 72 VdB in residential areas (FTA 2006).

For the purpose of this analysis, an action would be significant if it resulted in any the following:

- A peak particle velocity (PPV) greater than 0.3 inches per second (in/sec) at the receptor
- A vibration velocity level in decibels (L_v) greater than 72 VdB at the receptor

The criteria above were based on the characteristics of noise, published studies on vibration effects, and established regulations. Although Siskiyou County does not have local significance criteria for vibration levels, the significance criteria itemized above are expected to provide a conservative analysis of vibration levels.

3.23.4 Impact Analysis Approach

Evaluating potential noise and vibration impacts considers the baseline of existing conditions compared with the impacts of the Proposed Project. Noise and vibration levels were determined for proposed construction equipment (including blasting) and construction-related traffic using the methods described below[173]. A more detailed method description, analysis results, and data supporting the analysis are included in Appendix T.

Noise and vibration impacts were modeled in 2011 as part of the 2012 EIS/EIR analysis (Appendix T). Although there have since been some modifications to the Proposed Project schedule, the 2011 noise and vibration impact modeling is still relevant as the construction-related noise and vibration-generating activities for the Proposed Project are materially similar (see Section 3.22 *Transportation and Traffic*) to those modeled in 2011. Minor changes in proposed construction activities between the 2012 EIS/EIR analysis and the Proposed Project are primarily due to the timing associated with removing Iron Gate Dam, Copco No. 1 Dam, and Copco No. 2 Dam. The Proposed Project and the data modeled as part of the 2012 EIS/EIR are compared to the thresholds noted in Section 3.23.3.1 *[Noise] Thresholds of Significance* and analyzed in Section 3.23.5 *[Noise] Potential Impacts and Mitigation*.

Principles and methods described in FHWA's Roadway Construction Noise Model User's Guide (FHWA 2006) were the basis for predicting noise impacts associated with construction equipment (Appendix T). Table 3.23-4 presents noise levels of common

[173] Construction-related impacts are considered to be short-term impacts.

construction equipment operating at full power (L_{max}) measured 50 feet from the source, the percentage of time the equipment would be operated at full power (usage factor), and the L_{eq} over a single shift (Appendix T). For equipment whose L_{max} in the Roadway Construction Noise Model exceeds the maximum allowable noise levels from construction equipment in the Siskiyou County General Plan Noise Element (1978), the upper limits from Siskiyou County were used (Siskiyou County 1978).

Table 3.23-4. Construction Operations, Equipment Types, and Their Noise Levels.

Equipment Type	Usage Factor	L_{max} at 50 feet (dBA)	L_{eq} at 50 feet (dBA)
Air Compressor	40 percent	78	74
Backhoe	40 percent	78	74
Blasting	1 percent	94	74
Compactor	20 percent	83	76
Concrete Mixer Truck	40 percent	79	75
Concrete Pump Truck[1]	20 percent	81	74
Crane	16 percent	81	73
Dozers[1]	40 percent	81	77
Dump Truck	40 percent	77	73
Excavator	40 percent	81	77
Front End Loader	40 percent	80	76
Generator	50 percent	81	78
Generator (<25kVA)	50 percent	73	70
Grader	40 percent	85	81
Jackhammer[1]	20 percent	81	74
Mounted Impact Hammer (hoe ram)	20 percent	90	83
Pickup Truck	40 percent	75	71
Pumps	50 percent	77	74
Scraper	40 percent	84	80
Tractor[1]	40 percent	81	77

Source: Appendix T

[1] Maximum allowable noise levels from construction equipment at 100 feet from Siskiyou County's General Plan were converted to noise levels at 50 feet (by adding 6 dBA to account for the halving of distance).

Groundborne vibration is energy transmitted in waves through the ground. Groundborne vibration can cause building floors to shake, windows to rattle, hanging pictures to fall off walls, and in some cases can damage buildings. Vibration attenuates at a rate of approximately six to nine vibration decibels (VdB) for each doubling of distance from the source (FTA 2006). A conservative reduction rate of six VdB per doubling of distance was used in this study. This approach considers only the attenuation from geometric spreading and tends to provide for a conservative assessment of vibration level at the receiver's location.

The effects of construction-related noise and vibration on wildlife are evaluated in Section 3.5 *Terrestrial Resources*, and the analysis includes potential impacts as a result of noise disturbance greater than ambient conditions. Species-specific noise impacts on northern spotted owl included noise disturbance distances developed in coordination with the Arcata USFWS office using an estimation of auditory and visual disturbance effects (USFWS 2006) including a 1-mile buffer around all dams to account for the loudest noise disturbance distance associated with blasting, 0.5-mile buffer around all reservoirs to account for the loudest noise disturbance distance associated with helicopter use, and 0.25 mile buffer around all other areas within the Limits of Work to account for noise disturbance associated with heavy equipment.

The following source was assessed to determine the scope of existing local policies relevant to the Proposed Project:

- Siskiyou County General Plan Noise Element (Siskiyou County 1978).

The Siskiyou County General Plan Noise Element (1978) contains criteria for maximum allowable noise levels from construction equipment (Table 3.23-3). These criteria are discussed above in Section 3.23.3.1 *Thresholds of Significance* and the Proposed Project's potential conflict with these criteria is discussed below in Potential Impact 3.23-1.

3.23.5 Potential Impacts and Mitigation

This section summarizes the noise and vibration impacts that would be caused by the Proposed Project and recommends noise and vibration mitigation measures. The impact analysis for noise and vibration focuses on short-term construction-related activities, which include the pre-removal period, the dam removal period (zero to one years), and one to five years after dam removal, where the latter includes the majority of anticipated restoration and monitoring activities (Table 2.7-1 and Section 2.7.4 *Restoration Within the Reservoir Footprint*). While sporadic activities would occur throughout these periods and are analyzed herein, the following analysis is focused on the six-month period during the peak of the construction-related activity, when the three California dams would be removed. There would be no long-term noise and vibration impacts due to the Proposed Project as the Lower Klamath Project dam complexes would be removed.

Potential construction-related noise and vibration impacts on special-status wildlife species are evaluated in Section 3.5 *Terrestrial Resources,* including an analysis of potential short-term impacts to nesting birds (Potential Impact 3.5-12), willow flycatcher (Potential Impact 3.5-13), bald and golden eagles (Potential Impact 3.5-14), bats (Potential Impact 3.5-15), and northern spotted owl (Potential Impact 3.5-14).

Potential Impact 3.23-1 Use of standard construction equipment could exceed Siskiyou County General Plan criteria for maximum allowable noise levels from construction equipment.

For several specific types of construction equipment (specifically dozers, jackhammers, and tractors), the maximum allowable noise levels identified in the Siskiyou County General Plan Noise Element (Siskiyou County 1978) are lower than the typical noise levels produced by those equipment types according to the FHWA's Roadway Construction Noise Model User's Guide (FHWA 2006). This is summarized in Table 3.23-5. For the other 17 equipment types listed in the noise model, appropriate equipment noise levels consistent with FHWA 2006 were used. Given the maximum allowable noise levels identified in the Siskiyou County General Plan Noise Element (Siskiyou County 1978), any use of dozers, jackhammers, and/or tractors during the Proposed Project would constitute an exceedance of County maximum allowable noise levels and this would be a significant impact.

Table 3.23-5. Equipment Types for which Siskiyou County Maximum Allowable Noise Levels Exceed Typical Equipment Noise Levels.

Equipment Type	Siskiyou County Maximum Allowable Noise Level at 50 feet (dBA)[1]	Typical Equipment Noise Maximum Sound Level at 50 feet (dBA)[2]
Dozers	81	82
Jackhammers	81	89
Tractors	81	84

Source: Siskiyou County 1978, FHWA 2006

[1] Maximum allowable noise levels from construction equipment at 100 feet from Siskiyou County's General Plan were converted to noise levels at 50 feet (by adding 6 dBA to account for the halving of distance).

[2] Typical equipment noise levels at 50 feet are from FHWA 2006.

The Proposed Project includes a Noise and Vibration Control Plan (NVCP) (Appendix B: *Definite Plan – Appendix O5*) that would minimize short-term outdoor noise impacts, and which specifies that a Final NVCP, with additional details, would be required of the construction contractor. The proposed NVCP requires preparation and implementation of the Final NVCP and would be necessary to reduce potential noise impacts to the degree feasible. However the Final NVCP would not cause equipment noise levels from dozers, jackhammers, and tractors to comply with the Siskiyou County maximum allowable noise levels for these specific equipment types since the maximum allowable noise levels are lower than the typical noise levels produced by those equipment types according to the FHWA's Roadway Construction Noise Model User's Guide (FHWA 2006). Therefore, this impact would be significant and unavoidable.

Significance

Significant and unavoidable

Potential Impact 3.23-2 Construction activities at Copco No. 1 Dam could cause short-term increases in daytime and nighttime noise levels affecting nearby residents.

Noise disturbance associated with construction areas was evaluated to assess the potential to result in adverse physical and psychological responses (hearing loss and other health effects, such as anger and frustration), which can interfere with sleep, speech, and concentration; or diminish the quality of life. The Proposed Project would result in significant impacts if construction-related activities resulted in noise levels adversely affecting residents in the area.

The noise model (Appendix T) states that to comply with the Siskiyou County regulation, the maximum allowable noise level in the Siskiyou County General Plan Noise Element (1978) was used for equipment (specifically dozers, jackhammers, and tractors) whose maximum sound level (L_{max}) in the FHWA's Roadway Construction Noise Model User's Guide (FHWA 2006) exceeds the Siskiyou County regulation. This would cause the noise model (Appendix T) to slightly underestimate noise levels during construction. However, for the other 17 equipment types listed in the noise model, appropriate equipment noise levels consistent with FHWA 2006 were used.

The Proposed Project includes two shifts of construction workers to deconstruct each of the three California dams - Copco No. 1, Copco No. 2, and Iron Gate. At each dam the first work shift would be 6 a.m. to 4 p.m. and the second work shift would be 6 p.m. to 4 a.m. This would allow for 2-hour breaks between shifts for refueling and maintenance. Blasting would occur at each dam and would be restricted to 8 a.m. to 6 p.m. Note that the noise model (Appendix T) does not account for blasting during Shift 2 at Copco No. 1 Dam or during any work shift at Iron Gate Dam and thus underestimates the potential noise impacts. Both work shifts overlap with the daytime (defined as 7 a.m. to 10 p.m.) and nighttime (defined as 10 p.m. to 7 a.m.) (USEPA 1974). Table 3.23-6 lists the predicted average one-hour L_{eq} at Copco No. 1 Dam and Iron Gate Dam and at the receptors, the existing L_{eq} without the project, and the increase in noise level at the receptors that would occur as a result of the Proposed Project. (Copco No. 2 Dam removal was not analyzed as the line of sight to the closest receptor is assumed to be completely blocked, preventing noise disturbance at this receptor.) Significant increases in L_{eq} caused by the Proposed Project are shown in bold. Although the threshold of significance for this impact is "a greater than 10 dBA increase in the daytime or nighttime outdoor one-hour L_{eq} at the receptor from onsite construction operations," an increase of 9 dBA during Shift 2 at Copco No. 1 Dam was also identified as significant. This was meant to conservatively account for (1) the noise model's omission of blasting during Shift 2, and (2) the noise model's additional underestimation of construction noise due to use of Siskiyou County Maximum Allowable Noise Levels instead of typical noise levels for dozers, jackhammers, and tractors.

Table 3.23-6. Summary of Noise Levels from Construction Activities Compared to Existing.

Location[1]	**Time**	**Work Shift**	**Time of Day**[2, 3]	**L_{eq} (dBA)**			
				At Construction Site (50 feet)	**At Receptor with Proposed Project**	**Existing L_{eq} (dBA)**[4]	**Increase in L_{eq} Caused by Proposed Project**[5]
Copco No. 1 Dam	midnight–4:00 a.m.	Shift 2	Nighttime	88	49	30	**19**
	4:00 a.m.–6:00 a.m.	no work	Nighttime	30	30	30	0
	6:00 a.m.–7:00 a.m.	Shift 1	Nighttime	91	52	30	**22**
	7:00 a.m.–4:00 p.m.	Shift 1	Daytime	91	52	40	**12**
	4:00 p.m.–6:00 p.m.	no work	Daytime	40	40	40	0
	6:00 p.m.–7:00 p.m.	Shift 2	Daytime	88	49	40	**9**
	7:00 p.m.–midnight	Shift 2	Nighttime	88	49	30	**19**

Location[1]	Time	Work Shift	Time of Day[2, 3]	L_{eq} (dBA)			
				At Construction Site (50 feet)	At Receptor with Proposed Project	Existing L_{eq} (dBA)[4]	Increase in L_{eq} Caused by Proposed Project[5]
Iron Gate Dam	midnight–4:00 a.m.	Shift 2	Nighttime	91	45	30	**15**
	4:00 a.m.–6:00 a.m.	no work	Nighttime	30	30	30	0
	6:00 a.m.–7:00 a.m.	Shift 1	Nighttime	91	45	30	**15**
	7:00 a.m.–4:00 p.m.	Shift 1	Daytime	91	45	40	5
	4:00 p.m.–6:00 p.m.	no work	Daytime	40	40	40	0
	6:00 p.m.–7:00 p.m.	Shift 2	Daytime	91	45	40	5
	7:00 p.m.–midnight	Shift 2	Nighttime	91	45	30	**15**

Source: Appendix T
Notes:
1 J.C. Boyle Dam removal was not analyzed because there are no receptors within one mile and it is located in Oregon. Copco No. 2 Dam removal was not analyzed because the line of sight to the closest receptor is assumed to be completely blocked.
2 Daytime is defined as between the hours of 7:00 a.m. and 10:00 p.m. Source: USEPA 1974.
3 Nighttime is defined as between the hours of 10:00 p.m. and 7:00 a.m. Source: USEPA 1974.
4 Source: USEPA 1974. Also see Table 3.23-1.
5 Bolded numbers indicate exceedances of significance threshold.

The predicted L_{eq} from all construction equipment on a peak construction day at Copco No. 1 Dam is approximately 91 dBA at 50 feet during the first shift (6 a.m. to 4 p.m.) and 88 dBA during the second shift (6 p.m. to 4 a.m.) (Appendix T). Attenuation due to distance, atmospheric effects, ground absorption, and terrain effects would reduce this construction site's L_{eq} by approximately 39 dBA at the nearest receptor. Compared to the daytime and nighttime existing outdoor noise levels of 40 and 30 dBA, the resulting increase at Copco No. 1 Dam ranges from 9 to 22 dBA, depending on the time of day (Table 3.23-6 and Appendix T). Work during both shifts exceeds the significance criteria at all times because of the high source noise level. This increase in outdoor noise levels would have a short-term significant noise impact on the residential area near Copco No. 1 Dam.

The Proposed Project includes a Noise and Vibration Control Plan (NVCP) (Appendix B: *Definite Plan – Appendix O5*) that would minimize short-term outdoor noise impacts, and which specifies that a Final NVCP, with additional details, would be required of the construction contractor. The proposed NVCP requires preparation and implementation of the Final NVCP and would be necessary to reduce potential noise impacts to the degree feasible. However, the Final NVCP would not be enough to reduce short-term construction-related noise impacts to less than significant levels at sensitive receptors. Therefore, noise impacts would remain significant and unavoidable for outdoor receptors during Copco No. 1 Dam deconstruction.

Significance

Significant and unavoidable

Potential Impact 3.23-3 Construction activities at Copco No. 2 Dam could cause short-term increases in noise levels affecting nearby residents.
As described in Potential Impact 3.23-2, the Proposed Project would result in significant impacts if construction-related activities resulted in noise levels adversely affecting residents in the area. The closest noise-sensitive receptor to Copco No. 2 Dam and Powerhouse is the Janice Avenue rural residential area, located approximately 3,700 feet to the east of Copco No. 2 Dam (Figure 3.23-4). The line of sight from the receptor to Copco No. 2 Dam is blocked by a hill. Due to the natural topography surrounding the dam and the distance between the dam and the receptor, noise from on-site construction activities at the Copco No. 2 Dam would be reduced by more than 65 dB (approximately 35 dB by the distance and an additional 30 dB due to the topography). This amount of noise reduction would reduce noise impacts to less than significant levels at sensitive receptors**.** Measures specified in the Final NVCP would further reduce noise levels.

Significance
No significant impact

Potential Impact 3.23-4 Construction activities at Iron Gate Dam could cause short-term increases in nighttime noise levels affecting nearby residents.
As described in Potential Impact 3.23-2, the Proposed Project would result in significant impacts if construction-related activities resulted in noise levels adversely affecting residents in the area. The Proposed Project includes two shifts of construction workers to deconstruct Iron Gate Dam. The first work shift would be 6 a.m. to 4 p.m. and the second work shift would be 6 p.m. to 4 a.m. This would allow for 2-hour breaks between shifts for refueling and maintenance. Blasting would occur at Iron Gate to break mass concrete at any of the facilities to be removed (including intake structures, control structures, fish handling facilities, and powerhouse). Blasting would not occur as part of excavation of the Iron Gate Dam embankment material. Blasting would be restricted to 8 a.m. to 6 p.m. It is noted that the noise model (Appendix T) did not account for blasting during any work shift at Iron Gate Dam. Both work shifts overlap with the daytime (defined as 7 a.m. to 10 p.m.) and nighttime (defined as 10 p.m. to 7 a.m.) (USEPA 1974). Table 3.23-6 lists the predicted average one-hour L_{eq} at Iron Gate Dam and at the receptors, the existing L_{eq} without the project, and the increase in noise level at the receptors that would occur as a result of the Proposed Project. Significant increases in L_{eq} caused by the Proposed Project are shown in bold.

The predicted L_{eq} from the Iron Gate facilities removal is approximately 91 dBA at 50 feet during both shifts (6 a.m. to 4 p.m. and 6 p.m. to 4 a.m.). The combination of existing noise and attenuation due to distance, atmospheric effects, ground absorption, and terrain effects would result in a L_{eq} of approximately 46 dBA at the nearest receptor (Iron Gate Hatchery and associated facilities) (Table 3.23-6) (Appendix T). The estimated noise level at the receptor exceeds the significance criterion for nighttime noise during all proposed night work (7 p.m. to 4 a.m. and 6 a.m. to 7 a.m.). Construction noise would cause a short-term significant noise impact on the residential area near Iron Gate Dam at night. Implementation of the proposed NVCP (as described in Potential Impact 3.23-1) would reduce this noise impact; however, it would not reduce nighttime outdoor noise impacts to less than significant levels at sensitive receptors. Thus, nighttime noise impacts would remain significant and unavoidable for outdoor receptors during Iron Gate Dam nighttime deconstruction.

Significance
Significant and unavoidable

Potential Impact 3.23-5 Reservoir restoration activities at Copco No. 1 and Iron Gate could result in short-term increases in noise levels affecting nearby residents. The Proposed Project would result in significant impacts if reservoir restoration activities resulted in noise levels adversely affecting residents in the area. Equipment, including planes, barges, trucks, and helicopters, would be used for reservoir restoration at the same time as and subsequent to dam deconstruction. This reservoir restoration activity would add to the noise levels generated by dam deconstruction activities in and around the dam sites described above. Hydroseeding methods include by barge along the reservoir bank, by helicopter along steep slopes, by airplane along uneven large areas, and by trailer-mounted blower for areas easily accessible by truck. Equipment noise from embankment restoration would cause a short-term significant noise impact on the residential areas near the Copco No. 1 and Iron Gate reservoirs and contribute to the noise levels generated by dam deconstruction in and around the dam sites. The Proposed Project includes development of a NVCP (Appendix B: *Definite Plan – Appendix O5*) to minimize noise impacts from construction activities. Implementation of the Final NVCP would reduce short-term outdoor noise impacts, but given that they would add to already significant noise levels (Potential Impacts 3.23-2 and 3.23-4), noise impacts would remain significant and unavoidable for outdoor receptors during the reservoir restoration activities.

Significance
Significant and unavoidable

Potential Impact 3.23-6 Blasting activities at Copco No. 1, Copco No. 2, and Iron Gate Dams could increase daytime vibration levels affecting nearby residents. The Proposed Project would result in significant impacts if blasting activities resulted in vibration levels adversely affecting residents in the area. Blasting at each dam is proposed to occur infrequently, would be restricted to the time between 8 a.m. and 6 p.m., and would be dependent on scheduling. The predicted vibration levels at sensitive receptors are summarized in Table 3.23-7. Significant increases in PPV or L_v caused by the Proposed Project are shown in bold. Blasting during the first shift at Copco No. 1 Dam is anticipated to result in PPV and L_v at the nearest receptor of 0.065 in/sec and 84 VdB, respectively. For reference, vibration levels without blasting are 0.002 in/sec and 53 VdB (Table 3.23-7) (Appendix T). Therefore, the first shift at Copco No. 1 Dam would exceed the significance criteria for L_v (L_v greater than 72 VdB at the receptor). Construction activities during the second shift at Copco No. 1 (in which no blasting would occur) are anticipated to result in PPV and L_v at the nearest receptor of 0.001 in/sec and 47 VdB, respectively. The vibration model (Appendix T) did not account for the proposed blasting at either of the other dams. Blasting at Copco No. 2 and Iron Gate is proposed to occur infrequently between 8 a.m. and 6 p.m. Therefore it is conservatively assumed that vibration levels at Copco No. 2 and Iron Gate dams during Shift 1 would also exceed the threshold of significance.

Table 3.23-7. Summary of Vibration from Construction Activities.

Location[1]	Time of Day[2]	PPV at Receptor (in/sec)	L_v at Receptor (VdB)[3]
Copco No. 1 Dam	Shift 1	0.065 (0.002 without blasting)	**84** (53 without blasting)
	Shift 2	0.001	47
Copco No. 2 Dam	Shift 1	**no data available**[4]	**no data available**[4]
	Shift 2	no data available, but no blasting proposed[4]	no data available, but no blasting proposed[4]
Iron Gate Dam	Shift 1	**no data available**[4]	**no data available**[4]
	Shift 2	no data available, but no blasting proposed[4]	no data available, but no blasting proposed[4]

Source: Appendix T

1 J.C. Boyle was not analyzed because there are no receptors within one mile and it is in Oregon

2 Shift 1 is 6:00 a.m. to 4:00 p.m. and Shift 2 is 6:00 p.m. to 4:00 a.m.

3 Bolded numbers indicate exceedances of significance threshold(s)

4 The Appendix T noise and vibration model did not include blasting at Copco No. 2 or Iron Gate dams.

Key:

in/sec = inches per second

Construction activities (including blasting) would result in significant human annoyance levels for daytime vibration impacts at receptors near each of the three dams. The Proposed Project includes a Noise and Vibration Control Plan (NVCP) (Appendix B: *Definite Plan – Appendix O5*) that would minimize short-term outdoor noise impacts, and which specifies that a Final NVCP, with additional details, would be required of the construction contractor. The proposed NVCP requires preparation and implementation of the Final NVCP and would be necessary to reduce potential noise impacts to the degree feasible. The Final NVCP would minimize short-term outdoor noise impacts during blasting activities, but would not reduce impacts to less than significant levels at sensitive receptors. Therefore, daytime vibration impacts to humans would remain significant and unavoidable for outdoor receptors during the blasting activities.

Significance

Significant and unavoidable

Potential Impact 3.23-7 Transporting waste to off-site landfills and construction worker commutes could cause increases in traffic noise along haul routes affecting nearby residents.

The Proposed Project would result in significant impacts if hauling or commuting activities resulted in noise levels adversely affecting residents along the haul routes. Noise effects from transporting waste and construction worker commutes were evaluated for receptors at 50 feet and 500 feet from the road. TNM2.5 modeling results showed only minor increases in existing L_{eq} for receptors 50 feet or more from all haul routes analyzed (Table 3.23-8). Transporting waste off-site and construction worker commutes would result in less than significant noise impacts for receptors 50 feet or more from all local roadways. The Proposed Project includes a Noise and Vibration Control Plan (NVCP) (Appendix B: *Definite Plan – Appendix O5*) that would minimize short-term outdoor noise impacts, and which specifies that a Final NVCP, with additional details, would be required of the construction contractor. The proposed NVCP requires preparation and implementation of the Final NVCP and would be necessary to reduce potential noise impacts to the degree feasible. Implementation of the Final NVCP would reduce short-term construction-related noise impacts along haul routes to less than significant.

Table 3.23-8. Summary of Construction-Related Traffic Noise from Off-site Hauling and Construction Worker Commuting for the Proposed Project.

Haul Route/Commute Segment	Peak 1-hour L_{eq} (dBA)		Increase in L_{eq} Caused by Proposed Project (dBA)[1]	
	50 ft	500 ft	50 ft	500 ft
Ager-Beswick Road	54	43	1	1
Copco Road	63	51	5	5
I-5: Between OR-66 and Yreka, CA	77	66	0	0

Source: Appendix T
Notes:
[1] The increase in L_{eq} may appear different when subtracting the existing 1-hour L_{eq} from peak 1-hour L_{eq} values due to rounding.
Key:
ft = feet

Significance
No significant impact

Potential Impact 3.23-8 Construction activities associated with the Downstream Flood Control project component (moving or elevating legally established structures with flood risk) could produce noise and vibration associated with construction activities.
Construction activities associated with the Downstream Flood Control project component (moving or elevating legally established structures located within the altered 100-year floodplain, where feasible) (Section 2.7.8.4 *Downstream Flood Control*) could produce noise and vibration associated with construction activities. The Downstream Flood Control project component includes moving or elevating structures that could be affected by changes to the 100-year flood inundation area as a result of dam removal. These activities would take place before or after the primary construction and deconstruction activities associated with the Proposed Project; therefore, noise from these activities would not add to the noise and vibration impacts. These construction activities are generally smaller efforts, compared to dam removal, and would not cause a substantial increase in noise to sensitive receptors. As a result, construction associated with the Downstream Flood Control project component would cause a less than significant noise and vibration impact to sensitive receptors.

Significance
No significant impact

Potential Impact 3.23-9 Construction activities associated with implementation of Mitigation Measure WSWR-1 (modify water intakes) could produce noise and vibration associated with construction activities.
Mitigation Measure WSWR-1 could produce noise and vibration associated with construction activities. It provides protection for downstream water intakes during the passage of eroded sediment, which may include installing temporary facilities (e.g., settling basins or groundwater wells). These activities would take place before or after the primary construction and deconstruction activities associated with the Proposed

Project; therefore, noise from these activities would not add to the noise and vibration impacts. These construction activities are generally smaller efforts, compared to dam removal, and would not cause a substantial increase in noise to sensitive receptors. As a result, construction associated with Mitigation Measure WSWR-1 would cause a less than significant noise and vibration impact to sensitive receptors.

Significance
No significant impact

Potential Impact 3.23-10 Construction activities associated with the deepening or replacement of existing groundwater wells adjacent to the reservoirs could produce noise and vibration affecting nearby residents.
Construction activities associated with deepening or replacing existing groundwater wells adjacent to the reservoirs (see Potential Impact 3.7-1) would take place before and/or after the primary construction and deconstruction activities associated with the Proposed Project (i.e., dam removal); therefore, they would not add to these noise and vibration impacts. Construction activities associated with the deepening or replacement of wells are generally smaller construction efforts that would not cause a substantial increase in noise to sensitive receptors. Therefore these activities would cause a less than significant noise and vibration impact to sensitive receptors.

Significance
No significant impact

3.23.6 References

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3.24 Cumulative Effects

3.24.1 Introduction

3.24.1.1 Analysis Approach

CEQA requires a discussion of a project's cumulative impacts on the physical environment (CEQA Guidelines Section 15130). Cumulative impacts are defined as follows:

> *"Cumulative impacts" refers to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.*
>
> *(a) The individual effects may be changes resulting from a single project or a number of separate projects.*
>
> *(b) The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time."*

(CEQA Guidelines Section 15355).

Determinations of cumulatively considerable effects is required by CEQA Section 15065[a][3] *Mandatory Findings of Significance*, and CEQA Section 15130 guides the discussion of cumulative impacts. Three questions are useful to make determinations:

1. Does the Proposed Project make an adverse contribution to the impact in question?
2. Is the combined impact of the Proposed Project and other projects significant and adverse?
3. Is the Proposed Project's incremental effect cumulatively considerable?

CEQA states that when a project's contribution is not cumulatively considerable, then the EIR need only briefly describe supporting reasoning for this conclusion (CEQA Guidelines Section 15130[a][2]).

To perform the cumulative impact analysis, CEQA recommends relying on one of two approaches (CEQA Guidelines Section 15130[b]):

- List Approach: a list of past, present, and probable future projects producing related or cumulative impacts, or
- Projection Approach: a summary of projections contained in an adopted general plan or planning document, or in a prior environmental planning document, which has been adopted or certified, that describes or evaluates regional or area-wide conditions contributing to the cumulative impacts.

In this analysis, a list approach is used (Table 3.24-1) to analyze potential cumulative effects for each resource area, considering specific impacts of the Proposed Project in combination with potential impacts of other projects. When utilizing a list, the following factors should be considered: (1) the nature of each environmental resource being examined, and (2) the location of the project and its type (CEQA Guidelines Section 15130[b][1][B][2]). The list for the Proposed Project cumulative effects analysis includes the following planned, approved, or reasonably foreseeable project types that would result in related or cumulative impacts when considered in combination with the Proposed Project: riverine restoration projects; terrestrial resource management, conservation and restoration projects; water flow and water quality resource management projects; wildfire; forest and wildfire management projects; cannabis cultivation projects; other agricultural and rural residential projects; mining and mining withdrawal projects; infrastructure and energy projects; other rezoning and development projects; and recreation projects. This cumulative impact analysis focuses on projects that are not already considered in the analysis of potential impacts on environmental resources due to actions and elements included in the Proposed Project (Section 2). Past environmental conditions, including significant projects implemented before NOP issuance, are captured by the assessment of existing conditions in the *Environmental Setting* section of each resource area analysis. We note that the existing conditions included consideration of the NMFS and USFWS 2013 Joint Biological Opinion (2013 BiOp) flow requirements for the USBR Klamath Irrigation Project (NMFS and USFWS 2013), but the cumulative effects analysis considers the additional winter-spring surface flushing flows and deep flushing flows, as well as emergency dilution flows, that became a requirement in 2017 (U.S. District Court 2017). Additionally, measures PacifiCorp has committed to undertake as part of the KHSA upon certain triggers related to implementation of the Proposed Project are considered in this cumulative effects' analysis.

While wildfire is a natural occurrence, and an 'emergency' (CEQA Section 15359) rather than a foreseeable 'project' (CEQA Section 21065) under CEQA, with climate change more frequent and intense wildfires are reasonably foreseeable in California (Bedsworth et al. 2018). The area of the Proposed Project in Siskiyou County has been classified as having either high or very high wildfire hazard potential (CALFIRE 2007). Wildfires have the potential to result in relevant impacts (e.g., erosion and sediment deposition in streams) when combined with the Proposed Project, therefore this cumulative effects analysis considers increased frequencies and intensities of wildfires along with the list of 'projects' that could result in cumulative impacts (Table 3.24-1).

Significance criteria for cumulative effects vary by resource considered, and they are identical to those used to determine significance for Proposed Project impacts in each resource area. Classifications of significance differ from those used in resource areas, because of the mandatory requirement to assess cumulatively considerable effects (CEQA Section 15065[a][3]). The cumulative effects analysis concludes with a significance determination as follows (note that clarifying information is provided in non-bold font):

- ***Beneficial cumulative effects*** – when effects are cumulatively beneficial.
- ***No significant cumulative impact*** – when the combined impact of the Proposed Project and other projects would not be significant and adverse (and would also not be beneficial with sufficient certainty to describe it as such).
- ***Not cumulatively considerable*** – when the combined impact of the Proposed Project and other projects would be significant and adverse, but the incremental contribution of the Proposed Project would not be cumulatively considerable.
- ***Not cumulatively considerable with mitigation*** – when the combined impact of the Proposed Project and other projects would be significant and adverse, and the

incremental contribution of the Proposed Project requires mitigation to reduce it to less than cumulatively considerable.

- ***Cumulatively considerable*** – when the combined impact of the Proposed Project and other projects would be significant and adverse, and the incremental contribution of the Proposed Project is cumulatively considerable (and there is no feasible mitigation).

Table 3.24-1. List of Planned, Approved, or Reasonably Foreseeable Projects (Plus Wildfires) that Would Potentially Result in Related or Cumulative Effects When Combined with the Proposed Project (prepared September 2018).

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Riverine Restoration Projects					
USDA Forest Service—Klamath National Forest (Federal Lands)	Snackenburg Creek Project—restoration of channel connectivity and reduction of sedimentation into the stream where Snackenburg Creek crosses Forest Road over an area of 1,508 acres; Water Board Waiver Category B	Goosenest Ranger District, Klamath National Forest; 20 miles northwest of Macdoel, CA; Deer Creek, Klamath	In planning phase, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Elk Creek Watershed Project—integrated resource management project that aims to improve physical and biological conditions in the Elk Creek watershed, including road management, over 45,922 acres; Water Board Waiver Category B	Happy Camp Ranger District, Klamath National Forest	In planning phase, 2018; implementation expected in 2020	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Kelly Bar Habitat Enhancement Project—enhance off-channel riparian habitat including improving connectivity and enhancing side channels, creating alcoves on Kelly Bar and West Bar, and enhancing two off-channel ponds on Kelly Bar over an area of 12 acres	Salmon River Ranger District, Klamath National Forest; Kelly Gulch is located on the North Fork Salmon River 14 miles upstream from its confluence with the South Fork of the Salmon River, and approximately 28.5 miles from the mouth of the Salmon River	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
National Fish and Wildlife Foundation	Klamath Basin Restoration Program—current applicants include Combined PacifiCorp, Klamath River Coho Enhancement Fund and USBR, Klamath River Coho Habitat Restoration Program	Klamath Basin	Grants advertised in 2018, soon to be announced	NFWF 2018	https://www.nfwf.org/klamathbasin/Pages/2018rfp.aspx
PacifiCorp	Coho Enhancement Fund: PacifiCorp has agreed to make annual payments of $510,000 into the Coho Enhancement Fund for each year that the permit (authorizing the potential incidental take of SONCC coho salmon) is in effect even though PacifiCorp has already made payments of $510,000 per year into the Coho Enhancement Fund for 2009, 2010, 2011 and 2012	Klamath Basin	2009-2020	PacifiCorp 2012 (pp. 141–142)	http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Hydro/Hydro_Licensing/Klamath_River/KR_Coho_HCP_Feb162012Final.pdf
USBR	Klamath River Coho Restoration Grant Program (approximately $500,000 annually) See projects funded under this program in rows below.	Klamath Basin	2013-2023	USFWS and NMFS 2013 (pp. 278–279)	https://www.fws.gov/klamathfallsfwo/news/2013%20BO/2013-Final-Klamath-Project-BO.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USBR and Mid-Klamath River Instream Working Group	Projects funded under the Klamath River Coho Restoration Grant Program in 2018: Increasing Year-Round Rearing Capacity & Habitat Quality for Natal & Non-Natal Populations of Coho Salmon in a Priority Lower Klamath Tributary – McGarvey Beaver Dam Analogue Project; and Lower Beaver Creek Off-Channel Habitat Restoration Planning	McGarvey Beaver Dam, and Lower Beaver Creek	In planning phase, 2018	USBR 2018a	https://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=62330
USBR and NMFS	Klamath River Coho Habitat Restoration Grant Program 2017 Grant Slate: (1) Lower Mill Creek Habitat Enhancement for Coho Salmon; (2) Lower Scott Valley Stream Habitat Restoration; (3) Horse Creek Supplemental Design Project; (4) Floodplain Habitat Restoration and Monitoring to Restore Salmon in the Klamath Basin	Klamath Basin	Funded in 2017	NFWF 2017	https://www.nfwf.org/klamathbasin/klamathcoho/Documents/2017grantslate.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USBR and NMFS	Klamath River Coho Habitat Restoration Grant Program 2016 Grant Slate–projects include: (1) Middle Klamath Coho Refuge Habitat Enhancement – Planning and Design Team Support; (2) Horse Creek Wood Loading; (3) Increasing Year-Round Rearing Capacity and Habitat Quality for Natal and Non-Natal Populations of Coho Salmon in a Priority Lower Klamath Tributary; (4) Parks Creek Fish Passage Implementation Project; (5) Development of Cold Water Habitat for Coho Salmon; (6) Bogus Creek Fish Passage for Coho Salmon; (7) Cold Creek Coho Passage and Screening Project; (8) Lower French Creek Off-Channel Habitat Development; (9) Klamath National Forest Coho Habitat Enhancement in Horse Creek, China Creek and Little Horse Creek; (10) Parks Creek Fish Passage Design and Planning: Cardoza Ranch; (11) Lower Yreka Creek Restoration Project; (12) Lower Beaver Creek Coho Salmon Off-Channel Habitat Restoration	Klamath Basin	Funded in 2016	NFWF 2016	https://www.nfwf.org/klamathbasin/klamathcoho/Documents/klamathcoho_2016grantslate.pdf
Mid Klamath Watershed Council	Coho Habitat Enhancement and Monitoring Project–project will construct 1 and monitor 14 coho off-channel sites	Klamath River between Horse Creek and Camp Creek	Funded in 2015	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Mid Klamath Watershed Council	Mid Klamath Tributary Fish Passage Improvement Project–create fish passage at the mouths and in the lower reaches of 72 Mid Klamath sub-basin tributaries in California to allow for adult and juvenile anadromous fish passage into upstream channels and off-channel rearing habitat	Mid Klamath Subbasin (Mid-Klamath, Salmon, and Lower Scott Rivers) in northern CA	Funded in 2011, 2012, and renewed funding in 2014 and 2015	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf
Mid Klamath Watershed Council	Mid Klamath Coho Rearing Habitat Enhancement Project–enhance cover complexity through placement of small woody debris and willow plantings within pools of the lower reaches of Klamath River tributaries; project will provide summer refugia that will increase coho survival rates from predation, resulting in increased coho populations	Siskiyou and Humboldt Counties, CA	Funded in 2010, 2011, 2012, and renewed funding in 2015	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf
Humboldt, Del Norte, Trinity, Siskiyou and Mendocino Counties	Five Counties Salmonid Conservation Program (5C Program)—includes managing sediment discharge from roads	Humboldt, Del Norte, Trinity, Siskiyou and Mendocino Counties, CA	1998–Present	Five Counties Salmonid Conservation Program 2018	http://www.5counties.org/roadmanual.htm

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Trinity County Resource Conservation District (TCRCD)	West Weaver Creek Salmonid Habitat Rehabilitation Project—rehabilitation of a 490-linear-feet section of creek impacted by past mining practices and wildfires, including restoration of the channel and floodplain connectivity, and improvement of salmonid habitat and natural creek function over a project area of 2.39 acres	West Weaver Creek, partly within Weaverville Community Forest, just West of Weaverville	Construction completed in 2017, revegetation completed in 2018	TCRCD 2018a	http://www.tcrcd.net/index.php/2014-02-05-08-30-03/west-weaver-creek-salmonid-habitat-rehabilitation-project
California Department of Transportation, District 2–Northeastern California	Fort Goff Creek Fish Passage Improvement—prevent entrainment of fish into an existing water diversion ditch where they could be injured or killed over a two-acre project area; conserve water for the benefit of salmon and steelhead trout in Fort Goff Creek and the Klamath River	Fort Goff Creek, Siskiyou County, CA; water diversion/fish exclusion structure will be constructed at same site as current water diversion which is at RM 0.6 on Fort Goff Creek	Funded in 2012; on hold 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
Karuk Tribe, Fisheries Department	Lower Seiad Creek Channel Restoration—restoration of 4,000 lineal feet of stream; also known as part of the Klamath River Riparian Habitat Restoration—part of the Klamath River Coho Enhancement Fund (2010-0500-015)	Seiad Creek intersection with the Klamath River, CA	2015–2018	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf
Yurok Tribe	Restoring Off-Estuary Habitat in Hoppaw Creek, Klamath River—rearing habitat for natal and non-natal juvenile Coho salmon in an off-estuary tributary of the Klamath River; restoration effectiveness will be assessed; part of the Klamath River Coho Enhancement Fund (2010-0500-020)	Hoppaw Creek is a 3rd order stream that enters the Klamath River 2.6 miles upstream of the Pacific Ocean, Del Norte County, CA	Funded in 2013; ongoing in 2016	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Yurok Tribe	Lower Klamath Coho Rearing Habitat Case Studies–work with the Klamath Basin partners to 1) finalize the off-channel case study template, 2) develop Coho Rearing Habitat Case Studies for all of the Lower Klamath sites, 3) conduct physical and biological assessments of constructed off-channel features for a minimum of six sites, and 4) conduct outreach measures	Trewer Creek, CA	Funded in 2014	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf
PacifiCorp	Gravel Enhancement below Iron Gate Dam for Coho Salmon–gravel augmentation program is to be implemented in the Klamath River downstream of Iron Gate dam to improve coho spawning and rearing habitat	Iron Gate Dam	Funded in 2014; gravel placed in 2014, 2016, and 2017	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf
Trinity River Restoration Program (U.S. Department of the Interior Bureau of Reclamation as NEPA lead agency; North Coast Regional Water Quality Control Board as CEQA lead agency; USDA Forest Service: Shasta-Trinity National Forest and U.S. Department of Interior Bureau of Land Management as federal cooperating agencies; Hoopa Valley Tribe and Yurok Tribe as cooperating tribal agencies)	Trinity River Restoration Program (TRRP) Channel Rehabilitation and Sediment Management Program and Site-specific Remaining Activities—increase salmon and steelhead habitat over a 40-mile reach; construction of slow water refuge habitats, reconnection of the floodplain, placement of in-river geomorphic and habitat features, revegetation of riverine and upland areas	Mainstem Trinity River from Lewiston Dam to the North Fork Trinity River (see specific locations in rows below)	FONSI signed in 2009	USBR 2009	https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=3138

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Trinity River Restoration Program (includes U.S. Bureau of Reclamation and U.S. Bureau of Land Management as federal co-leaders, and North Coast Regional Water Quality Control Board, Regional Water Board as state lead agency)	2015 Trinity River Restoration Program (TRRP) at Limekiln Gulch—increase salmon and steelhead downstream of Lewiston Dam	Limekiln Gulch (RM 99.7–100.6)	FONSI singed in 2015	USBR 2015	https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=20621
Trinity River Restoration Program (includes U.S. Bureau of Reclamation and U.S. Bureau of Land Management as federal co-leaders, and North Coast Regional Water Quality Control Board, Regional Water Board as state lead agency)	2016 Trinity River Restoration Program (TRRP) at Bucktail Site	Bucktail (RM 105.45–107.0); begins upstream of Bucktail Bridge and extends upstream 1.5 miles	FONSI signed in 2016	USBR 2016	https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=23209
Trinity River Restoration Program (includes U.S. Bureau of Reclamation and U.S. Bureau of Land Management as federal co-leaders, and North Coast Regional Water Quality Control Board, Regional Water Board as state lead agency)	2017 Trinity River Restoration Program (TRRP) at Deep Gulch and Sheridan Creek	Deep Gulch and Sheridan Creek (RM 81.6–82.9); southeast of Junction City	In planning phase, 2018	USBR 2017a	https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=27594

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Terrestrial Resource Management, Conservation and Restoration					
USDA Forest Service—Rogue River-Siskiyou National Forest (All Units)	Forest Wide Sensitive Plant Habitat Enhancement and Huckleberry Restoration in the SIA and HCRD; Huckleberry restoration will take place in Jackson Creek and Headwaters of the Rogue River	Rogue River-Siskiyou National Forest (All Units)—includes part of Siskiyou County	In planning phase, 2018	USDA Forest Service 2018b	https://www.fs.fed.us/sopa/components/reports/sopa-110610-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Siskiyou Mariposa Lily Enhancement on Gunsight Ridge—pest management to enhance mariposa lily habitat over 5,566 acres (8,380-acre project area); Water Board Waiver Category A, expected	Scott River Ranger District, Klamath National Forest; about 3 miles west and slightly north of Yreka, within the Humbug-Klamath River, Yreka Creek-Shasta River, and Moffett Creek 5th field watersheds	In planning phase, 2018; implementation expected 2019	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Deschutes National Forest (Federal Lands)	Addition of aminopyralid to the list of available herbicides in the Deschutes Forest Plan—invasive weed management and control	Deschutes National Forest, OR	In planning phase, 2018	USDA Forest Service 2017a	https://www.fs.usda.gov/nfs/11558/www/nepa/107783_FSPLT3_4106136.pdf
California Wildlife Conservation Board	Climate Adaptation and Resiliency Program—created by AB109; program funds are to be used for climate adaptation and resiliency projects that will result in enduring benefits to wildlife, including: grants for the acquisition of perpetual conservation easements and long-term conservation agreements; natural and working lands adaptation and resiliency planning	CA	Applications closed August 2018	CAWCB 2018b	https://www.wcb.ca.gov/Programs/Climate-Adaptation

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Water Flow and Water Quality Resource Management Projects					
U.S. Bureau of Reclamation, National Marine Fisheries Service (NMFS), and U.S. Fish and Wildlife Service	Re-consultation of the 2013 Joint Biological Opinion Flows (2013 BiOp Flows) for the Klamath Irrigation Project, including the 2017 court-ordered flushing and emergency dilution flows	Klamath River dams and downstream reaches	Court Order Feb 8, 2017	U.S. District Court 2017	https://www.govinfo.gov/content/pkg/USCOURTS-cand-3_16-cv-04294/pdf/USCOURTS-cand-3_16-cv-04294-7.pdf
California Natural Resources Agency	The Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1) authorizes $7.545 billion in general obligation bonds to fund ecosystems and watershed protection and restoration, water supply infrastructure projects, including surface and groundwater storage, and drinking water protection	CA wide	In progress since 2014	California Natural Resources Agency 2015	http://bondaccountability.resources.ca.gov/p1.aspx
California Wildlife Conservation Board	Proposition 1 Stream Flow Enhancement Program—Proposition 1 authorized the Legislature to appropriate $200 million to the Wildlife Conservation Board (WCB) to administer the California Stream Flow Enhancement Program (Program). The Program awards grant funding on a competitive basis to projects representing the mission of the WCB, and address the three goals of the California Water Action Plan: reliability, restoration, and resilience	CA	Applications for the 2018 Proposal Solicitation Notice and Application closed September 2018; projects must be complete by 2023	CAWCB 2018a	https://www.wcb.ca.gov/Programs/Stream-Flow-Enhancement

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
U.S. Department of the Interior, Bureau of Reclamation, Northern California Area Office	Long Term Plan to Protect Adult Salmon in the Lower Klamath River—addresses potential effects of flow-related actions to reduce the likelihood and potential severity of an Ich (*Ichthyophithirius mutifillis*) epizootic event that could lead to fish die-off; Ich grows on gills and suffocate fish; includes flow augmentation, with minimum flow of 2,800 cfs downstream of Lewiston Dam	Lower Klamath River, downstream of Lewiston Dam	Record of Decision signed, 2017 (note 2012, 2013, 2015 and 2016 minimum flow releases were separate planning processes)	USBR 2017b (note that 2012, 2013, 2015, and 2016 minimum flow releases were separate planning and release processes)	https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=22021
California Wildlife Conservation Board (California Stream Flow Enhancement Program FY 2016/17)	Hart Ranch Instream Flow Enhancement—proposal is to consider the allocation for an implementation grant to California Trout (CalTrout) for a cooperative project with United States Fish and Wildlife Service (USFWS), Natural Resources Conservation Service (NRCS), The Nature Conservancy (TNC), and UC Davis Center for Watershed Sciences to dedicate instream, through a California Water Code section 1707 transfer, 1.5 cfs of cold water to the Little Shasta River through a combination of on-farm efficiency savings and voluntary flow contributions, located on privately-owned land six miles east of Montague in Siskiyou County	Little Shasta River, six miles east of Montague, Siskiyou County	In planning phase, 2017	CalTrout 2017	https://caltrout.org/2017/03/caltrout-receives-grants-fish-passage-improvement-projects/

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
California Department of Water Resources	Sustainable Groundwater Management Act (SGMA)—high and medium priority basins are required to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge	CA	Signed in 2014, currently in progress	DWR 2018	https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management
Siskiyou County	In Siskiyou County, Butte Valley, Shasta Valley, and Scott River Valley, as well as the Tulelake sub-basin, are designated as medium priority basins under SGMA	Butte Valley, Shasta Valley, Scott River Valley, and Tulelake sub-basin, Siskiyou County, CA	Signed in 2014, currently in progress	Siskiyou County 2015	https://www.co.siskiyou.ca.us/sites/default/files/public_docs/PLN-20151013_BOS-MEMO_ReSGMA-Update_v1002_WithAttachments.pdf
Scott River Water Trust	Emergency Stream Augmentation for the Scott River—to benefit salmon	French Creek, Miners Creek, and the mainstem Scott River	Funded in 2014	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf
Scott River Water Trust	Improving Streamflow for Coho Salmon in the Scott River	Scott River sub-basin, CA	Funded in 2010	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf
Montague Water Conservation District	MWCD-Shasta River Flow Enhancement Project	The southern portion of the Shasta River watershed, centered near Dwinnell Reservoir in Siskiyou County, CA	Funded in 2013	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
City of Yreka (partly funded by a Flood Hazard Reduction grant from the California Department of Water Resources)	City of Yreka 2016 Greenway Master Plan and Flood Hazard Reduction Project—includes: enhancing fish habitat, recreational opportunities, educational opportunities, improved law enforcement and public security, Coho recovery, flood hazard reduction, water quality improvement, stormwater management in small tributaries, trail system expansion and linkages, widening of Yreka Creek, excavations adjacent to Yreka Creek, overflow floodwater channels, removing soils from the floodway, expanding greenway corridors	Yreka Creek and other streams, Yreka, CA	In planning phase, 2016	City of Yreka 2016	https://ci.yreka.ca.us/sites/ci.yreka.ca.us/assets/files/_Yreka_2016_Greenway_Master_Plan_DEIR.pdf
IM1 – Interim Measures Implementation Committee (IMIC)	The IMIC is comprised of representatives from PacifiCorp, other parties to the KHSA (as amended on November 30, 2016), and non-signatory representatives from the State Water Board and Regional Water Board (see KHSA Appendix B, Section 3.2). The purpose of the IMIC is to advise on implementation of the Non-Interim Conservation Plan Interim Measures set forth in Appendix D of the Amended KHSA.	CA and OR	Ongoing	KHSA 2016	https://www.doi.gov/sites/doi.gov/files/uploads/FINAL%20KHSA%20PDF.pdf
PacifiCorp	Klamath Hydroelectric Settlement Agreement (KHSA) Interim Measure (IM) 11 Water Quality Improvement Project—draft priority list of projects identifies diffuse source treatment wetlands; riparian restoration; large scale wetland restoration; agricultural	OR	Not yet occurred–to be funded after acceptance of FERC surrender order	KHSA 2016	https://www.doi.gov/sites/doi.gov/files/uploads/FINAL%20KHSA%20PDF.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
	water conservation piping; PacifiCorp shall spend up to $250,000 per year to be used for studies or pilot projects developed in consultation with the Implementation Committee to improve interim water quality in the Klamath River; $5.4 Million one-time funding and $560,000 annually in maintenance for long-term nutrient reduction would occur				
PacifiCorp	KHSA Interim Measure (IM) 16 Water Diversion Projects—elimination of three screened diversions from Shovel (2) and Negro (1) Creeks; modify water rights to move points of diversion to the mainstem of the Klamath	CA	Not yet occurred	KHSA 2016	https://www.doi.gov/sites/doi.gov/files/uploads/FINAL%20KHSA%20PDF.pdf
North Coast Regional Water Quality Control Board	Various grants for water quality improvement projects through money received from the USEPA through Section 319(h) of the Clean Water Act and Timber Regulation and Forest Restoration Fund. Projects must be in nonpoint source pollution priority watersheds and priority is given to projects that address TMDL implementation and those that address problems in impaired waters.	CA	Ongoing	SWRCB 2018	https://www.waterboards.ca.gov/water_issues/programs/nps/319grants.html
North Coast Regional Water Quality Control Board	Waste discharge requirements, waivers, and National Pollutant Discharge Elimination System (NPDES) permits issued and renewed with updated best management practices (BMPs) on a regular basis	CA	Ongoing	NCRWQCB 2018, pers. comm.	N/A

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
North Coast Regional Water Quality Control Board, Oregon Nature Conservancy, Klamath Tribes, Klamath Watershed Partnership, Trout Unlimited, Oregon Department of Environmental Quality, US Fish and Wildlife Service	Upper Klamath Basin Watershed Action Team implements various projects generally located in the Upper Klamath Lake, Wood River, Sprague River, Williamson River	OR and CA	Ongoing	NCRWQCB 2018, pers. comm.	N/A
U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, Klamath Water Users Association, irrigation districts, Oregon Department of Environmental Quality, North Coast Regional Water Quality Control Board	Watershed Stewardship Partnership works with landowners, agencies, and other partners to conserve, enhance, and restore natural resources of the Klamath Basin through education, consultation, and restoration. Various water quality improvement projects and practices are generally implemented in the Upper Klamath River, Lower Klamath Lake, Lost River, Klamath Irrigation Project	OR	Ongoing	KWP 2018	http://www.klamathpartnership.org/programs.html
Wildfire					
CALFIRE	2016 Fires in CA—Old, Moffett, Gap, Grade, Tully, Summit, Stafford, Table, Bailey, Pony, and Mill Fires; Acres burned: Del Norte (105 acres), Humboldt (768 acres), Siskiyou (844 acres), Trinity (4 acres)	CA	2016	CALFIRE 2016	http://cdfdata.fire.ca.gov/incidents/incidents_archived?archive_year=2016&pc=20&cp=1
ODF	2016 Fires in OR—5,661-acre Withers Fire northeast of Klamath Falls	OR	2016	ODF 2016	https://www.OR.gov/ODF/Documents/Fire/2016_Protection_Division_Fire_Season_Report.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
CALFire	2017 Fires in CA—Miller Complex, Eclipse, Young, and Orleans Fires	CA	2017	CALFIRE 2017	http://cdfdata.fire.ca.gov/incidents/incidents_archived?archive_year=2017
ODF	2017 Fires in OR—Crane Creek, Jade Creek, and Naylox in the vicinity of Klamath Falls; Acres burned in OR (717,212 acres), and on ODF lands (47,165 acres)	OR	2017	ODF 2017	https://www.OR.gov/ODF/Documents/Fire/2017_ODF_Protection_Fire_Season_Report.pdf
CALFire	2018 Fires in CA—Mill Creek 1, Natchez, Klamathon, Watson Creek, Iron Gate, Cherry, Steamboat, Lott, Johnson, Petersburg, Meamber, Martin, Grape, Ager, and Shastina Fires	CA	2018	CALFIRE 2018	http://www.fire.ca.gov/current_incidents
ODF	2018 Fires in OR—Watson Creek Fire in OR	OR	2018	ODF 2018	http://wildfireORdeptofforestry.blogspot.com/2018/08/watch-out-for-watson-creek-fire.html

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Forest and Wildfire Management Projects					
USDA Forest Service — Klamath National Forest (Federal Lands)	Horse Creek Community Protection and Forest Restoration Project—reduce fuels, reduce safety hazards, and restore previously stocked units that were burned in the 2016 Gap Fire over 7325 acres and 103 lineal road miles	Happy Camp/Oak Knoll Ranger District of Klamath National Forest; this includes north, northwest, and northeast of the town of Horse Creek, CA up to the border of CA and OR and the Rogue-River Siskiyou National Forest	In late planning phase, 2017	USDA Forest Service 2017b	https://www.fs.usda.gov/project/?project=50586
USDA Forest Service — Klamath National Forest (Federal Lands)	Harlan—management for wildfire, including prescribed fire, strategic fuel breaks, and thinning; improve forest health and diversity, including resilience to insects and disease; maintain historic grassland and shrubland habitats; improve foraging habitat for elk and deer; protect cultural resources; and provide for safe public access to open roads; Water Board Waiver Category B	Goosenest Ranger District, Klamath National Forest; the project is located within the Horsethief Creek, Lough Lake, Lower Butte Creek, Prather Creek, and Upper Butte Creek 6th field watersheds; directly west and north of the community of Bray, CA, and approximately eight miles south of Macdoel in Siskiyou County	In planning phase, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service — Klamath National Forest (Federal Lands)	Lucky Penny—thinning of 1,500 acres of pine plantation within about a 2,300 acre project area to promote stand health, reduce fuel, and accelerate development of late-successional characteristics; Water Board Waiver Category A.	Goosenest Ranger District, Klamath National Forest; 20 miles northwest of Macdoel, CA	In planning phase, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service — Klamath National Forest (Federal Lands)	Pumice Vegetation Management Project—addresses deteriorating forest health conditions, increasing hazardous fuel conditions, and reduced ecological diversity, all caused by a century of fire exclusion and past management activities over an area of 9056 acres; Water Board Waiver Category B	Goosenest Ranger District, Klamath National Forest; Tamarack Flat (18010204130100) 7th field watershed; between Garner Mountain and Davis Rd (S. of four corners)	In planning phase, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Six Shooter Project—addresses the lack of young to mid-aged shrubs for big game, deteriorating forest health conditions, and increasing hazardous fuel conditions over an area of 15,067 acres; Water Board Waiver Category A, expected	Goosenest Ranger District, Klamath National Forest; the project is located within the Antelope Well, Dock Well, Hill 22, and Six Shooter Pass 7th field watershed	In planning phase, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Crawford Vegetation Management Project—thinning in stands for forest health and fuels reduction, with fuel treatments, including under-burning and pile burning on about 1,600 acres; Water Board Waiver Category B	Happy Camp Ranger District, Klamath National Forest	In progress; implementation expected in 2019	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Hancock Forest Management Access Road—construct 2,300 feet of temporary and 300 feet of permanent roadbeds for log hauling for forest use and management purposes	Happy Camp Ranger District, Klamath National Forest; Mill Creek 7th Field Watershed	In planning phase, 2018; implementation expected in 2020	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service—Klamath National Forest (Federal Lands)	Oak Fire Roadside Hazard Tree Proposal—reduce threats to public safety along 31 miles of National Forest Transportation System roads within the Oak Fire perimeter; Water Board Waiver Category A, expected	Happy Camp Ranger District, Klamath National Forest	In planning phase, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Seiad-Horse Risk Reduction Project—reduce safety hazards along roads and in concentrated stands, reduce fuels adjacent to private property, reduce the risk of future large-scale high severity fire losses of late successional habitat, and place large woody debris in streams for fish and wildlife habitat restoration in response to the 2017 Abney Fire, over an area of 10,800 acres	Happy Camp / Oak Knoll Ranger District of Klamath National Forest, Seiad Creek-Klamath River and Horse Creek-Klamath River 5th field watersheds—five miles North to Northeast of Seiad Valley, CA, in Siskiyou County	In planning phase, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Callahan Complex Fuels Treatment on Private Land CE—fuel reduction on 200 acres of private land	Salmon River Ranger District, Klamath National Forest; private land in and around the community of Callahan, Siskiyou County	In planning phase, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Salmon August Reforestation Project—reforestation on 155 acres of lands burned during the 2017 Salmon-August Complex fire (1,093 acres); primarily restocking of conifer-dominated stands	Salmon River Ranger District, Klamath National Forest; located about five miles northwest of Sawyers Bar, CA, and within the Cherry Creek and Specimen Creek areas of the North Fork Salmon River Watershed	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service—Klamath National Forest (Federal Lands)	Salmon August Reforestation Project—Planting Unit 450-40 Only CE; to promote reforestation on lands burned during the 2017 Salmon-August Complex fire	Salmon River Ranger District, Klamath National Forest; located about 5 miles northwest of Sawyers Bar, CA, and within the Cherry Creek and Specimen Creek areas of the North Fork Salmon River Watershed	Completed in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Yellow Jacket Ridge—2,600 acres of precommercial thinning, release and fuels reduction in plantations and in natural stands	Salmon River Ranger District, Klamath National Forest	In planning phase, 2018; implementation expected 2019	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Craggy Vegetation Management—improve fire resiliency by reducing fuels and stand density in strategic areas (11,000-acre treatment area) to protect communities and promote forest health	Scott River Ranger District, Klamath National Forest; near Yreka, CA	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	East Fork Scott—improve conditions within the E Fork Scott watershed; treatments may include meadows, riparian areas, fuels reduction, mine reclamation, stand density reduction, and wildlife habitat improvements over 31,540 acres	Scott River Ranger District, Klamath National Forest; 10 miles NE of Callahan, Siskiyou County	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service—Klamath National Forest (Federal Lands)	Upper North Fork Salmon Fuels Reduction—treatment of 120 acres with high priority fuels reduction and prescribed fire on private land	Salmon River Ranger District, Klamath National Forest; private properties in the upper North Fork Salmon River drainage from Little North Fork to Taylor Hole; North Fork Salmon River 5th Field Watershed	On hold, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Lover's Canyon—commercially thin about 863 acres, non-commercially thin about 1,103 acres, create fuel breaks on about 255 acres, and underburn about 2,223 acres over a total project area of 4,444 acres	Scott River Ranger District, Klamath National Forest; 15 miles west of Fort Jones, CA, within 7 drainages of the Lower Scott River Watershed	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Steamboat Oak Habitat Improvement—fuels reduction and oak woodland habitat improvement and retention for improved defensible space adjacent to the CALFIRE Deadwood Camp, improved wildlife habitat, increased fire resiliency, and overall forest health over an area of 45.5 acres	Scott River Ranger District, Klamath National Forest; 5 miles north of Fort Jones, CA, Siskiyou County; located on the ridge between Soares and Steamboat Gulch adjacent to the CALFIRE Deadwood Camp in the McAdams Creek Drainage	In planning phase, 2018; expected implementation 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service—Klamath National Forest (Federal Lands)	Yreka WUI Hazardous Fuels Reduction on Private Land—fuel reduction over 250 acres, additional acreage in future stages	Scott River Ranger District, Klamath National Forest; West of the city of Yreka, in the Middle Fork Humbug Creek, Greenhorn Creek, Yreka City—Yreka Creek, Long Gulch, and Rocky Gulch—Yreka Creek 7th field watershed	In planning phase, 2018; implementation expected 2019	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Somes Bar Integrated Fire Management—remove fuels prior to prescribed burning in plantations 40 years and older, and mature natural stands while enhancing cultural and ecological plant species; shaded fuel breaks are proposed, and temporary roads are considered on a case by case basis over a project area of 5,570 acres	Scott River Ranger District, Klamath National Forest	In planning phase, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
TCRCD	California Fire Safe Council CWPP Implementation Phase I: OR Mountain area of Weaverville—mechanical chipping and thinning over 1.2 miles of roadside shaded break; 50 acres completed to date	OR Mountain area of Weaverville, including OR St and Dutch Ln	Work initiated in 2017	TCRCD 2018b	http://www.tcrcd.net/index.php/2014-02-05-08-30-03/forest-health

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Cannabis Cultivation Projects					
City of Yreka	A City Council-initiated Ordinance entitled "Non-Medical Marijuana Cultivation Regulation and the Prohibition of Commercial Cannabis Activity, Manufacture, Testing, Dispensing, Sales, Distribution and Delivery within all Zoning Districts in the City of Yreka" (note that indoor cultivation is regulated, not prohibited)	City of Yreka limits	Adopted, 2017	Yreka Planning Commission 2017	http://ci.yreka.ca.us/sites/ci.yreka.ca.us/assets/files/P_C_Mintues_7_19_17.pdf
Humboldt Healing Collective; Aronsen Peter M Tr (owner)	Special Permit (SP) under Humboldt County Commercial Medical Marijuana Land Use Ordinance—existing outdoor cannabis cultivation; there are two points of water diversion and a rain catchment; includes 63,400-gallon water storage in hard tanks onsite on a 9,976-square-foot site	Willow Creek area, Humboldt County; North side of SH 299, 4.86 miles from the intersection of Titlow Road and SH 299	In planning phase, 2018	Humboldt County 2017a	https://humboldtgov.org/DocumentCenter/View/5523/summary-chart-of-projects-opened-by-the-Current-Planning-Division-in-the-previous-month?bidId=
Oak Knob, LLC	Conditional Use Permit for existing outdoor and mixed light cannabis cultivation—includes relocation of cultivation away from streamside, a new well and drip irrigation system on a 43,560-square-foot site; projected water use is 250,000 gallons/year; water is from an existing spring diversion, with storage in tanks, bladders, and a rainwater catchment pond; processing will occur offsite	Willow Creek area, Humboldt County; West side of SH 299, 12.42 miles from the intersection of SH 299 and Friday Ridge	In planning phase, 2018	Humboldt County 2017a	https://humboldtgov.org/DocumentCenter/View/5523/summary-chart-of-projects-opened-by-the-Current-Planning-Division-in-the-previous-month?bidId=

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
SJH Timber, Inc	Cannabis nursery in Trinity Alps Business Park—construction of two 3,000-sqare-foot greenhouses, and a 3,600-square-foot commercial building for sales, research and development, and storage	Trinity Alps Business Park, 271 Industrial Park Way, Weaverville, Trinity County, CA; outside 100-year floodplain of Weaver Creek	In planning phase, 2018	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Various applicants	Variance from required 350-foot cannabis cultivation setback—there are several applications for the same variance	Lewiston, Hayfork, and other locations in Trinity County	In planning phase, 2018	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Sungold Flat, LLC	SP to relax the 600-foot setback requirement from Six Rivers National Forest—an associated Zoning Clearance is concurrently being processed for 10,000 square feet of new commercial medical cannabis cultivation, and 20,000 square feet of Retirement, Remediation, and Relocation (RRR) cultivation referred to as Lorie Harbor; 30,000-square-foot total area	1570 Patterson Road, Willow Creek, Humboldt County, CA	In planning phase, 2018	Humboldt County 2018a	https://humboldtgov.org/AgendaCenter/ViewFile/Agenda/_05102018-1077
Patterson Flat, LLC	SP to relax the 600-foot setback requirement from Six Rivers National Forest—the proposed cannabis cultivation area totaling 50,000 square feet is being permitted under three separate applications	1570 Patterson Road, Willow Creek, Humboldt County, CA	In planning phase, 2018	Humboldt County 2018b	https://humboldtgov.org/AgendaCenter/ViewFile/Agenda/_04192018-1069

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Sacred Earth Apothecary	SP for an existing commercial cannabis operation consisting of 7,000 square feet of outdoor cultivation and 2,111 square feet of mixed-light cultivation—5.1-acre parcel; water is supplied by the Willow Creek Community Services District, and estimated annual water usage is 65,000 gallons	1255 State Highway 96, Willow Creek area, Humboldt County, CA	In planning phase, 2018	Humboldt County 2018c	https://humboldtgov.org/AgendaCenter/ViewFile/Agenda/_03222018-1055
Enchanted Earth, LLC Special Permit	SP to relax the 600-foot setback requirement from Six Rivers National Forest—an associated Zoning Clearance is concurrently being processed for 2,000 square feet of commercial medical cannabis cultivation	212 Enchanted Spring Lane, Willow Creek area, Humboldt County, CA	In planning phase, 2018	Humboldt County 2018d	https://humboldtgov.org/AgendaCenter/ViewFile/Agenda/_01182018-1027
Green Star Ranch, Inc	SP for an existing 7000 sq-ft cannabis cultivation operation consisting of 2,000 square feet of mixed light and 5,000 square feet of outdoor with onsite relocation—water is provided by the Willow Creek Community Services District, and estimated annual water usage is 14,400 gallons; total onsite water storage is 300 gallons in a mixing-tank, and processing occurs onsite	2525 Patterson Road, Willow Creek, Humboldt County, CA	In planning phase, 2017	Humboldt County 2017b	https://humboldtgov.org/AgendaCenter/ViewFile/Agenda/_12142017-1015

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Willow Creekside Farms	SP for an existing 10,000-square-foot medical cannabis cultivation operation—cultivation will consist of a 1,800-square-foot mixed-light greenhouse and an existing 8,200-square-foot outdoor cultivation area on a 10,000-square-foot site; total onsite storage capacity is 5,500 gallons in 4 storage tanks, and irrigation water is by the Willow Creek Community Services District	230 Creekside Lane, Willow Creek, Humboldt County, CA	In planning phase, 2017	Humboldt County 2017c	https://humboldtgov.org/AgendaCenter/ViewFile/Agenda/_09212017-975
Other Agricultural and Rural Residential Projects					
USDA Forest Service—Klamath National Forest (Federal Lands)	Bray and Horsethief Grazing Allotment Analysis—grazing management / reauthorization of grazing under the Rescissions Act of 1995, Water Board Waiver Category B	Goosenest Ranger District, Klamath National Forest, including: Bray, 13 miles SE of Macdoel, CA, and Horsethief, 10 miles SW of Macdoel, CA, 5th-field watersheds: Butte Creek, Antelope Creek-Red Rock, and Little Shasta River	In planning phase/public comment period, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Cattle Guard Installation on Forest Road 46N50—install cattle guard in Horse Creek Special Interest Area	Happy Camp Ranger District, Klamath National Forest; on the Horse Creek road (Forest Road 46N50) about 1/2 mile beyond the forest boundary	In planning phase, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Dry Lake and Horse Creek Grazing Allotment Management—grazing management plan over 78,566 acres; Water Board Waiver Category B, expected	Happy Camp Ranger District, Klamath National Forest; north of Highway 96 near the communities of Horse Creek and Oak Knoll in Siskiyou County	In planning phase, 2018-2019; implementation expected in 2020	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service—Klamath National Forest (Federal Lands)	Arland Costa Special Use Permit Renewal—renew permit for livestock area	Scott River Ranger District, Klamath National Forest	On hold, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Lake Mountain & Middle Tompkins Grazing Allotment Management Plan Project—reauthorization of grazing permits over 28,864 acres	Scott River Ranger District, Klamath National Forest; Oak Knoll and Scott River RD boundary near Lake Mtn and Tom Martin Pk	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
Siskiyou County, Agritourism Technical Advisory Committee, Planning	AG1, AG2, and RR Zoning Modifications for Agritourism	Siskiyou County, CA	In planning phase, 2018	Siskiyou County 2018a	https://www.co.siskiyou.ca.us/sites/default/files/public_docs/TAC_20180606_AgritourismTACResolution_Signed20180517.pdf
Siskiyou County, Multispecies Livestock Technical Advisory Group, Planning	AG1, AG2, and RR Zoning Modifications to allow certain pastured hog and poultry operations	Siskiyou County, CA	In planning phase, 2018	Siskiyou County 2018b	https://www.co.siskiyou.ca.us/sites/default/files/public_docs/TAC_20180606_MultispeciesTACResolution_Signed20180517.pdf
Humboldt County Planning and Building Department	Titlow Hill General Plan Amendment, Zone Reclassification, and Subdivision Application—historic illegal subdivisions with residential and agricultural development proposed to be corrected over an area of 6,244 acres; the existing illegal development includes surface water diversions as water sources, and septic systems for the houses	Central Humboldt County, south of SR 199 and west of Titlow Hill Road; 12 miles west of Willow Creek	In planning phase, 2018	Humboldt County 2018e	https://humboldtgov.org/DocumentCenter/View/62953/Titlow-Hill-Extended-Notice-of-Preparation-of-a-Draft-Environmental-Impact-Report-1-31-18-PDF?bidId=

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
JH Ranch; planning processing by Siskiyou County	Planned Development (PD) Plan Amendment for JH Ranch—increase the amount of land in the existing PD District from 79 acres to 201 acres, and modify the PD to accommodate existing operations; retain existing maximum capacity of 482 persons; retain and renovate guest cabins, tent-like cabins, staff cabins, homes, and bunk cabins	French Creek Road, Siskiyou County	In planning phase, 2016	Siskiyou County 2018c	https://www.co.siskiyou.ca.us/content/planning-division-jh-ranch-documentation
Kidder Creek Orchard; planning processing by Siskiyou County	Kidder Creek Orchard Camp Zone Change and Use Permit—rezoning 170 acres from Timberland Production District to Rural Residential Agricultural (40-acre minimum parcel size); increase of allowable camp occupancy from 165 to 844; increase of physical camp size from 333 acres to 580 acres; structures, recreation features, a pond, and ancillary activities	South Kidder Creek Road, 2 miles west of SH 3, south of Greenview in the Scott Valley, Siskiyou County	In planning phase, 2018	Siskiyou County2018d	https://www.co.siskiyou.ca.us/content/planning-kidder-creek-orchard-camp
Grady Padgett	Cannaworx Zone Change—rezone 44 acres from Open Space to Non-Prime Agricultural, Initial Study / Mitigated Negative Declaration	21635 Walker Road, 11 miles southwest of Yreka, Klamath River, Siskiyou County, CA	Adopted, 2018	Siskiyou County 2018e	https://www.co.siskiyou.ca.us/sites/default/files/public_docs/PLN-20180525_Z1505_CannaworxNOA_NOI.pdf
Gary Black	Grenada Irrigation District, Huseman Relocation Instream Phase	Shasta River, CA	Funded in 2010	NFWF 2016	https://www.nfwf.org/klamathriver/Documents/krcef_2015_totalprojects.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Judi Nelson and Walter Wood	Proposed Negative Declaration—rezone 33.53 acres from Unclassified to Agriculture; Use Permit to allow operation of a six-bedroom bed and breakfast facility, conference room, outdoor kitchens, a barn and agricultural building	6301 South Fork Road, nine miles south of Highway 299, near the town of Salyer, Trinity County, CA	In planning phase, 2018	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Chris Yordana	Rezone from Unclassified to Rural Residential, and create four parcels (20-acre minimum)—286.35-acre project area	420 Blake Mountain Trail, Hyampom, Trinity County, CA	In planning phase, 2018	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Nikola Rakocevic	Rezone from Special Unit Development to Rural Residential (10-acre minimum)—40-acre project area	701 Lorenz Rest, off Tucker Hill Road, Douglas City, Trinity County, CA	In planning phase, 2018	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Peter Dimopoulos	Rezone two parcels from Unclassified to Agriculture, 40-acre minimum—10-acre project area	18393 Zenia-Lake Mountain Road, Zenia, Trinity County, CA	In planning phase, 2017	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Bob Morris	Rezone property from Unclassified to Agricultural and Agricultural Forest—29.5-acre area	4060 and 4311 Little Browns Creek Road (County Road No. 223), Trinity County, CA	In planning phase, 2016	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Mining and Mining Withdrawal Projects					
USDA Forest Service—Klamath National Forest (Federal Lands)	Brooks Mine—existing Brooks mining claim with a new plan of operations over an area of 20 acres; mining using backhoe, 2.5-cubic-yard dump truck, grizzly, and trammel; opening existing road to new extraction site; Water Board Waiver Category A	Happy Camp Ranger District, Klamath National Forest; near Humbug Creek	On hold, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service—Klamath National Forest (Federal Lands)	China Point—response to proposed Plan of Operations to mine the 30-acre China Point unpatented claim in compliance with the General Mining Act of 1872	Salmon River Ranger District, Klamath National Forest; located between the NF Salmon River and the Salmon River Rd; NE of Forks of Salmon in Siskiyou City, South of the Sawyers Bar Road and North of the N Fork Salmon Rd	In planning phase, 2018; implementation expected 2019	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Discovery Day Mine—Plan of Operations proposed to mine 20 acres of the 950-acre Discovery Day claim, which is an established mine site with a road, three working pads, and underground tunnels	Salmon River Ranger District, Klamath National Forest; located on the southeast side of a ridge between the east and west fork drainages of Knownothing Creek in the Klamath National Forest, approximately three miles southeast of Forks of Salmon	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Schwartz and Leff Mineral Withdrawal—application to administratively withdraw 39.6 acres of National Forest System Lands along the North Fork Salmon River from mineral location and entry under the U.S. Mining Laws for a period of 20 years to protect cultural resources (mining history and intact structures)	Salmon River Ranger District, Klamath National Forest; located on the North Fork of the Salmon River about four miles upriver from the community of Forks of Salmon in Siskiyou County	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service—Klamath National Forest (Federal Lands)	Wisniski Special Use Permit Amendment—1/4-mile existing road access to the Mountain Laurel Mine for commercial haul of ore to mill site, and add a private water line; Water Board Waiver Category B	Salmon River Ranger District, Klamath National Forest, CA	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
Del Norte County—Randy Hooper, Assistant Director	Annual Surface Mine Use Permit Renewals	Del Norte County	In planning phase, 2018	Del Norte County Planning Commission 2018	http://countyofdelnorte.us/agendas/agenda_management/agendas/PLN1345.pdf
Hoopa Valley Tribe	Copper Bluff Mine Remediation—copper, zinc, silver, and gold; involves heavy metals; acid mine drainage flows into the Trinity River; potential EPA Superfund Project	Hoopa Valley Reservation, adjacent to State Highway 96, Humboldt County, CA	Undefined (Ongoing)	USEPA 2018	https://www.epa.gov/newsreleases/us-epa-marks-one-year-anniversary-superfund-task-force-report-visit-copper-bluff-mine
Infrastructure and Energy Projects					
Pembina (as of 2017); previously Veresen	Jordan Cove Energy Project / Pacific Connector Gas Pipeline—234 mi, 36 in diameter	Malin, Klamath County, OR through Douglas and Jackson Counties to Coos County, OR (passes near Klamath Falls), includes Deschutes National Forest (USDA Federal Lands)	In planning phase, 2018	FERC 2015	https://www.ferc.gov/industries/gas/enviro/eis/2015/09-30-15-eis.asp
USDA Forest Service—Klamath National Forest (Federal Lands)	Ayres Waterline New Special Use Permit—special use management; water system consisting of 490 feet of 2-inch PVC pipe	Happy Camp Ranger District, Klamath National Forest; near Grider Creek, West Grider-Klamath River 7th Field Watershed	In planning phase, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service—Klamath National Forest (Federal Lands)	Caltrans Culvert New Special Use Permit—36 in culvert replacement using jack bore method	Happy Camp Ranger District, Klamath National Forest; Milepost 43.01 on State Highway 96, near Happy Camp, CA	Completed	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service	Lewiston Community Services District Wastewater Collection, Treatment and Disposal Project—this project will update and consolidate three existing community wastewater, treatment, and disposal systems over 96.06 acres; reclamation will provide a license for associated upgrades and continued use of existing percolation beds for the treatment system adjacent to Trinity River	Lewiston, Trinity County, CA; Trinity River bank—outside 100-year flood zone (due to construction of berms); about 16 miles southeast of Weaverville	FONSI signed in 2018	USBR 2018b	https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=34041
USDA Forest Service—Klamath National Forest (Federal Lands)	Siskiyou Telephone Fiber Optic Cable Installation Downriver CE / Special Use Permit Amendment (OAK57)—includes jack and bore methods under creeks, and hanging conduits over Clear Creek and Dillon Creek; Fish and Wildlife Stream Crossing Agreement required; 21.9 miles of road, 10,020 feet of trenchng, 87,784 feet of boring	Happy Camp Ranger District, Klamath National Forest; from 1/2 mile below Benjamin Creek to Dillon Creek, along Highway 96 (Post Miles 38.4-16.2); Oak Flat Creek, Benjamin Creek-Klamath River, Slippery Creek-Clear Creek 7th field watersheds	In planning phase, 2018; expected implementation 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	PacifiCorp Powerline Special Use Permit Renewal CE—30 miles of powerline replacement within a 270-acre project area; NCRWQCB Waiver exempt	Happy Camp Ranger District, Klamath National Forest; starts off County Road on Scott River Road, ends just south of Little Grayback Mountain	On hold, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
USDA Forest Service—Klamath National Forest (Federal Lands)	Bentley, H. New Special Use Permit—above-ground water-line, no new disturbance proposed	Salmon River Ranger District, Klamath National Forest; McNeal Creek-South Fork 7th Field Watershed	In planning phase, 2018; expected implementation 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	California Highway Patrol Special Use Permit Renewal CE—radio service facility on Eddy Gulch	Salmon River Ranger District, Klamath National Forest; Eddy Gulch Communications Site, about two miles north of Sawyers Bar, CA in the Eddy Gulch 7th field watershed	On hold, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Siskiyou Telephone Special Use Permit Amendment for Phone Line Installation—amend Special Use Permit to trench 1,100 feet to install an underground phone line to a private residence	Scott River Ranger District, Klamath National Forest; Lower Indian Creek 7th field watershed	On hold, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Burnett Road Easement New Special Use Permit—1,500-foot-long, 12-foot-wide road access to private property, and 1,000 foot of two-inch water-line	Happy Camp Ranger District, Klamath National Forest	In planning phase, 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
USDA Forest Service—Klamath National Forest (Federal Lands)	Schroeder Road Access New Special Use Permit—driving on 435 lineal feet of existing historic roadbeds to access private property; Water Board Waiver Category A	Goosenest Ranger District, Klamath National Forest; 12 miles southwest of Macdoel, CA, and 4 miles northwest of Grass Lake, CA	In planning phase, 2018; implementation expected in 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Siskiyou County Public Works	Guys Gulch Road Realignment—Guys Gulch Bridge and Approaches; Schulmeyer Gulch Bridge Approaches	Intersection of Guys Gulch and Old Highway 99 Intersection of Schulmeyer Gulch and Old Highway 99	In Progress, 2017–2018	Siskiyou County 2017	https://www.co.siskiyou.ca.us/content/public-works-contract-16-07-guysschulmeyer-gulch-bridges
Siskiyou County Public Works	Salmon River Road Flood Damage Repair—Federal Emergency Aid Relief Project	Salmon River Road, M.P. 5.76	In Progress, 2018	Siskiyou County 2018f	https://www.co.siskiyou.ca.us/content/public-works-contract-17-02-salmon-rv-rd-flood-damage-repair-at-mp-576
Siskiyou County Public Works	Wooley Creek Bridge Rehabilitation and Pier Repair	Wooley Creek Bridge (Bridge 2C-016)	Pending, 2018	Siskiyou 2018g	https://www.co.siskiyou.ca.us/content/public-works-fap-no-brlo-5902080-wooley-creek-bridge-rehabilitation-and-pier-repair
Siskiyou County, Planning	Denny Point Tower—80-foot lattice communications tower, cellular equipment shelters, electrical backup generators, cellular equipment cabinets, a foot access road, and trench for lines over a 7,000-sqare-foot project area	Near 3801 McConaughy Gulch Road, Etna, Siskiyou County, CA	In planning phase, 2018	Siskiyou County 2018h	https://www.co.siskiyou.ca.us/sites/default/files/public_docs/PC_20180615_DraftISMND_UP1804_Topsites-Plank.pdf
Del Norte County Community Development Department, Engineering Division	Hunter Creek Bridge Replacement Project	Requa Road at Hunter Creek, Klamath, CA	In planning phase, 2018; construction anticipated in 2020	Del Norte County 2017a	http://www.co.del-norte.ca.us/departments/community-development-department/engineering-division/projects

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Trinity County Department of Transportation, and Central Federal Lands Highway Division	Mitigated Negative Declaration for rehabilitation of Van Duzen Road and Ruth Zenia Road, which provide primary access to Six Rivers National Forest	Van Duzen Road (Post Miles 9.5–9.7, 11.2–11.6, and 12–15), 68 miles southeast of Eureka, Trinity County, CA	In planning phase, 2018	Trinity County Planning Commission 2018	http://www.trinitycounty.org/sites/default/files/Planning/documents/Agenda_Minutes/2018/01_2018/Item%206%20-%20FHWA%20RuthZenia_VanDuzen%20Staff%20Report%20P-17-11.pdf
Klamath Community Services District	Coastal Development Permit for a Wastewater Treatment System Expansion	Corner of Highway 101 and Klamath Boulevard, and the parcel directly across the Highway on Highway 101, Klamath	In planning phase, 2018	Del Norte County 2018a	http://countyofdelnorte.us/agendas/agenda_management/agendas/PLN1355.pdf
City of Yreka	Ringe Pool Facility Condition Assessment—options include: (1) short- and long-term repairs, (2) replacing the existing facility with new pools, (3) demolishing the facility and returning it to lawn; 0.88-acre site	Ringe Memorial Swim Center, Knapp St, Yreka	In planning phase, 2018	McCelland Architecture + Planning 2018	https://ci.yreka.ca.us/sites/ci.yreka.ca.us/assets/files/Ringe_FCA_Full_Report.09.17.18.pdf
City of Yreka	Proposed Mitigated Negative Declaration and Initial Study: Yreka Water Supply and Storage Improvements—includes public water system improvements, water tank replacements, installation of water mains, and installation of a new well	City of Yreka, unincorporated area of Siskiyou County, with improvements at: Lower Humbug Water Tank Site, Shasta Belle Water Tank Site, and Davis Well Site	In initial planning phase, 2017	City of Yreka 2017	http://ci.yreka.ca.us/sites/ci.yreka.ca.us/assets/files/P_C_Mintues_12_20_17.pdf
City of Yreka	Filter Pump Station / Primary Coagulent Facilities at Injection Station	Yreka, CA, about 20 miles from the Fall Creek Pump Station	Constructed	S. Baker, City Manager, pers. comm., October 2018	N/A

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
City of Yreka	Water Treatment Plant Upgrade	Yreka, CA	In engineering phase, 2018	S. Baker, City Manager, pers. comm., October 2019	N/A
City of Yreka	2.5 million gallon Clear Well	North end of Butcher Hill, Yreka, CA	Recently constructed	S. Baker, City Manager, pers. comm., October 2020	N/A
City of Yreka	Rehabilitation of Butcher Hill Reservoir	Yreka, CA	Recently constructed	S. Baker, City Manager, pers. comm., October 2021	N/A
City of Yreka	Backwash Pond Improvements	Intersection of Montague-Ager and Yreka-Ager, Yreka, CA	Recently constructed	S. Baker, City Manager, pers. comm., October 2022	N/A
AT&T mobile	Use Permit for a 96-foot cellular tower and appurtenant facilities on private property—800-square-foot project area	1240 Old Lewiston Road, Lewiston, Trinity County, CA	In planning phase, 2018	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Yurok Tribe	Coastal Grading Permit—waterline and storage tank replacement	Requa Area, Klamath, Del Norte County, CA	In planning phase, 2017	Del Norte County 2017b	http://countyofdelnorte.us/agendas/agenda_management/agendas/PLN1216.pdf
Resighini Rancheria	Extension of Time for a Coastal Grading Permit for Road Improvements and Culvert Replacement	Klamath Beach Road, and Waukell and Juniors Creek, Klamath, Del Norte County, CA	In planning phase, 2018	Del Norte County 2018	http://countyofdelnorte.us/agendas/agenda_management/agendas/PLN1256.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Other Rezoning and Development Projects					
USDA Forest Service—Forest Products Laboratory, Klamath National Forest	Nanocellulose Facility—microscopic timber processing	Yreka, CA	In planning phase, 2016	USDA Forest Service 2016	https://www.fs.usda.gov/detail/klamath/landmanagement/?cid=FSEPRD499729
USDA Forest Service—Klamath National Forest (Federal Lands)	Cecilville Fire & Hose Company Special Use Permit Amendment—installation of service building for the storage of fire trucks and rescue vehicles	Salmon River Ranger District, Klamath National Forest	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
Siskiyou County (Siskiyou County Planning/Board of Supervisors)	Siskiyou County Jail Project—39,000 square feet on an 84-acre parcel	269 Sharps Road, Yreka, Siskiyou County	In initial planning phase, 2018	Siskiyou County 2018i	https://www.co.siskiyou.ca.us/sites/default/files/public_docs/PLN-20180521_NOI_MND.pdf
Trinity County	Use Permit to construct 96-bed jail—31,000 square feet on an 11.9-acre site	701 Tom Bell Road, Weaverville, Trinity County, CA	In planning phase, 2016	Trinity County Planning Commission 2016	http://www.trinitycounty.org/sites/default/files/Planning/documents/Agenda_Minutes/2016/11_2016/Item%206%20-%20Use%20Permit%20for%20Construction%20of%20New%20Jail.pdf

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Trinity County	General Plan Amendment and Rezoning in Weaverville Planning Area (existing land use is lumber mill and undeveloped land)	Lance Gulch Road, between Browns Ranch Road and Highway 299	In planning phase, 2017	Trinity County Planning Commission 2017	http://www.trinitycounty.org/sites/default/files/Planning/documents/Agenda_Minutes/2017/02_2017/Item%205%20-%20GPA%20%26%20Rezone%20COT%20%26%20TRLC%20PW-17-01.pdf
Karuk Tribe	Karuk Tribe Casino Project / Rain Rock Casino—36,497 sq-ft	City of Yreka, CA—Tribal Trust land and land held in fee title by the Tribe	Under construction, 2017	Siskiyou County 2018j	https://www.co.siskiyou.ca.us/content/planning-division-karuk-tribe-casino-project
Cross Development, with City of Yreka as lead agency	Yreka Dollar General Retail Store Project—includes a parking lot, landscaping / tree planting, a retaining wall, and stormwater retention areas on a 3.43-acre parcel	North side of Montague Road / State Route 3 between N. Main St and Deer Creek Way	In planning phase, 2018	City of Yreka 2018	http://ci.yreka.ca.us/planning-commission/minutes
Sousa Ready Mix, LLC; with City of Yreka as lead agency	Sousa Ready Mix Concrete Batch Plant Project—Conditional Use Permit to allow the construction of a 4.26-acre concrete batch plant, complete with a small portable office trailer, aggregate storage area, truck and auto parking, precast concrete area, and concrete truck washout basin	319 South Phillipe Lane, Yreka, CA	In planning phase, 2016	City of Yreka 2018	http://ci.yreka.ca.us/planning-commission/minutes
Fruit Growers Supply Company, with City of Yreka as lead agency	Fruit Growers Supply Company Sawmill Project: Initial Study / Mitigated Negative Declaration	Industrial area at the eastern edge of Yreka, CA; accessed via South Phillipe Lane 229 South Phillipe Lane, Yreka, CA	In planning phase, 2018	City of Yreka 2018	http://ci.yreka.ca.us/planning-commission/minutes

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
SK Yreka Inc.	Consideration of proposed categorical exemption and Conditional Use Permit to construct, establish, and operate a new gas station and convenience store in the Commercial Tourist Zone	1801 Fort Jones Road, Yreka, CA	In planning phase, 2017	City of Yreka 2018	http://ci.yreka.ca.us/planning-commission/minutes
Campora Propane (Contractor Rick Bettis)	Consideration of proposed Categorical Exemption and Conditional Use Permit for construction establishment and operation of a fuel storage yard facility with two 30,000-gallon bulk propane storage tanks in the Light Industrial Zone	1420 Mill Road, Yreka, CA	In planning phase, 2016	City of Yreka 2018	http://ci.yreka.ca.us/planning-commission/minutes
Debora Behm	Consideration of proposed Categorical Exemption and Conditional Use Permit for the establishment and operation of a Microbrewery	204 W. Miner St, CA	In planning phase, 2016	City of Yreka 2018	http://ci.yreka.ca.us/planning-commission/minutes
Terry Mines	Rezone of four parcels from Highway Commercial to Industrial—5.65-acre project area	Marshall Ranch Road, Douglas City	In planning phase, 2018	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Steve Toney	Subdivide one parcel into two lots (A & B) and rezone Parcel B from General/Commercial to Mobile Home/Special Occupancy Park—8.5-acre project area	North and East side of the Trinity Plaza Shopping Center, Trinity County, CA	In planning phase, 2018	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Stephen & Susan Adams	One-year time extension of tentative map approval to create three parcels of approximately 40 acres each (currently vacant and residential)—120-acre project area	Van Duzen Road, 6.8 miles south of intersection with SH 36, Scott Glade, Mad River area (Ag Forest Zone), Trinity County, CA	In planning phase, 2017	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Mark and Vallerie Hollister	One-year time extension of tentative map approval to create four parcels and a remainder varying from 1 acre to 17 acres	1281 Carrville Loop Road, Coffee Creek (Residential Zone), Trinity County, CA	In planning phase, 2016	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Darrell & Marilyn Marlin	One-year time extension of tentative map approval to create two parcels of 2.5 acres each—5-acre total area	60 New Road, off Union Hill Road, Douglas City (Rural Residential Zone), Trinity County, CA	In planning phase, 2016	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Yingling Trust	One-year time extension of tentative map approval to create four parcels of approximately 2 acres each—8-acre total area	Private Road off Angel Hill Road, near Highway 3, Weaverville	In planning phase, 2016	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Donn and Oralynn Mulvey	Mulvey General Plan Amendment / Zone Change (from Residential Duplex to Commercial) / Parcel Map Creating Two Parcels	201 Clinic Avenue, Hayfork, Trinity County, CA	In planning phase, 2016	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports
Darwin Edge	Approve the Tentative Parcel Map for the subject property creating three parcels of 0.84 acres each	72 Bennett Road (County Road No. 249), Trinity County, CA	In planning phase, 2016	Trinity County 2018	http://www.trinitycounty.org/Agendas-Minutes-Staff-Reports

Applicant or Implementing Agency	Project/Program Name	Location	Timeframe	Reference	Website
Recreation Projects					
USDA Forest Service—Klamath National Forest (Federal Lands)	Recreation Outfitter and Guides Special Use Permits Analysis—reauthorization of Recreation Outfitter and Guide Special Use Permit	Scott River Ranger District, Klamath National Forest; Marble Mountains, Trinity Alps, Russian Wilderness, and nearby non-wilderness area	In planning phase, 2018; implementation expected 2018	USDA Forest Service 2018a	https://www.fs.fed.us/sopa/components/reports/sopa-110505-2018-04.pdf
Del Norte County	Off-Highway Motor Vehicle Recreation (OHV) Grants Program, Plan, and actions	Del Norte County	Plan completed, 2018	Del Norte County 2018b	http://www.co.del-norte.ca.us/departments/community-development-department/planning-division/del-norte-county-ohv-planning-project

3.24.1.2 Geographic Scope

CEQA requires that a geographic scope of the area affected by the cumulative effect is defined, and a reasonable explanation for the geographic limitation used (CEQA Guidelines Section 15130[b][1][B][3]). The Areas of Analysis for the assessment of cumulative effects of the Proposed Project, in combination with other projects, are stated at the start of the cumulative effects' analyses for each resource area. The Areas of Analysis for some resource areas have clearly defined cumulative assessment boundaries, while others are more general in nature owing to the type and nature of the potential impacts.

3.24.1.3 Timeframe

CEQA requires consideration of past, present, and probable future cumulative effects (CEQA Guidelines Section 15130[b]). Cumulative effects may occur over a longer timeframe than project-specific effects, and the timeframe for the cumulative effects analysis varies by environmental resource and impact. The Proposed Project would be implemented over several years (Table 2.7-1). For several resource area impacts, the cumulative effects analysis timeframe is the duration of pre-dam removal activities (pre-dam removal years 1−3) and dam deconstruction (dam removal years 1 and 2). For other resource area impacts, long-term effects could occur after dam removal, so for these a longer timeframe is considered. The timeframes for long-term cumulative effects are based on the best available existing information and consider the inherent difficulties of long-term forecasting. Unless otherwise specified, the timeframe for cumulative effects analyses is the same as for Proposed Project-related resource effects. As with the analysis of Proposed Project impacts, the analysis of cumulative effects uses 2016 conditions (issuance of the Notice of Preparation) as the baseline for existing resource conditions. Unless otherwise specified, historical trends and the effects of past projects are part of the existing conditions.

3.24.1.4 Mitigation

An EIR must examine reasonable, feasible options for mitigating or avoiding the project's contribution to any significant cumulative effects (CEQA Guidelines Section 15130[b][1][B][5]). Additionally, no public agency can approve or carry out a project with an EIR that identifies significant impacts, unless the public agency makes one or more written findings for each of those significant effects (CEQA Guidelines Section 15091). This assessment of cumulative effects identifies feasible mitigation measures for effects of the Proposed Project determined to be cumulatively considerable.

3.24.2 Water Quality

The geographic scope for cumulative water quality effects is the same as the Area of Analysis for water quality, as described in Section 3.2.1 *[Water Quality] Area of Analysis*. The geographic scope includes the Klamath River from the Hydroelectric Reach[174] in the Upper Klamath Basin through the Lower Klamath River from its confluence with the Trinity River, the Klamath River Estuary, and the Pacific Ocean nearshore environment (Figure 3.2-1).

[174] Reaches of the Klamath River upstream of the Oregon-California state line (RM 214.1) are considered to the extent cumulative actions in those reaches influence water quality downstream in California.

Water quality existing conditions in the Area of Analysis are described in Section 3.2.2 *[Water Quality] Environmental Setting* and Appendix C *Water Quality Supporting Technical Information*. The spatial and temporal trends in water temperature, suspended sediments, nutrients, dissolved oxygen, pH, chlorophyll-a and algal toxins, and inorganic and organic contaminants conditions for the Klamath River, from the Hydroelectric Reach through the Klamath River Estuary and the Pacific Ocean nearshore environment, are all detailed for the Area of Analysis. Section 3.2.2 *[Water Quality] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, water quality. Additionally, the reaches of the Klamath River listed as impaired on the Clean Water Act (CWA) section 303(d) list are presented in Section 3.2.3 *[Water Quality] Significant Criteria*, Table 3.2-3.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of water quality resource area effects (Section 3.2). The non-project activity types shown below have been evaluated for potential cumulative impacts on water quality and include those activities that would potentially alter water temperature, suspended sediments, nutrients, dissolved oxygen, pH, chlorophyll-*a* and algal toxins, and inorganic and organic contaminants in the Klamath River within the water quality Area of Analysis. While wildfire is a natural occurrence, under climate change more frequent and intense wildfires are reasonably foreseeable (Bedsworth et al. 2018) and thus wildfires are also evaluated for potential cumulative impacts on water quality. The non-project activity types are included in Table 3.24-1).

Significance criteria for cumulative water quality impacts are the same as defined in Section 3.2.3 *[Water Quality] Significance Criteria*.

Potential Cumulative Impact 3.24-1 Long-term water quality effects of the Proposed Project in combination with restoration, flow enhancement, and water quality improvement projects.

Restoration, flow enhancement, and water quality improvement projects along the Klamath River and its tributaries (creeks and rivers) are anticipated to enhance water quality (e.g., water temperature, suspended sediments, nutrients, dissolved oxygen, pH, chlorophyll-a and algal toxins), with improvements to stream channels, riparian habitat restoration, placement of off-channel habitat features, floodplain restoration, incorporation of large wood into tributaries to the Klamath River, and increases in stream flow (Table 3.24-1).

Restoration, flow enhancement, and water quality improvement projects would have a beneficial effect on water quality in the Klamath River. As an example, the Long Term Plan to Protect Adult Salmon in the Lower Klamath River is anticipated to improve nutrient, suspended sediment (i.e., organic matter concentrations), and chlorophyll-a and algal toxin conditions during August and September by increasing the Trinity River flows into the Klamath River and diluting (i.e., lowering) the nutrient, suspended sediment, and chlorophyll-a and algal toxin concentrations in the Lower Klamath River downstream of the Trinity River. Various grants for water quality improvement projects, through money received from the USEPA through Section 319(h) of the Clean Water Act and Timber Regulation and Forest Restoration Fund, reduce nonpoint source pollution (e.g., sediments, nutrients) and address TMDL implementation in the Klamath Basin. Waste discharge requirements, waivers, and NPDES permits are issued by the North Coast

Regional Water Quality Control Board for particular projects, and are renewed with updated BMPs on a regular basis, addressing a variety of water quality parameters (e.g., water temperature, dissolved oxygen, sediment, nutrients) throughout the Klamath Basin. A number of entities involved in the Upper Klamath Basin Watershed Action Team and the Watershed Stewardship Partnership (see Table 3.24-1) implement various projects throughout the Upper Klamath Basin that improve water quality through working with landowners, agencies, and other partners to conserve, enhance, and restore natural resources. Associated improvements in water quality in the Upper Klamath River, Lower Klamath Lake, Lost River, Klamath Irrigation Project, Upper Klamath Lake, Wood River, Sprague River, and Williamson River, will ultimately improve water quality in the Hydroelectric Reach, Middle and Lower Klamath River, and Klamath River Estuary.

The conversion of the reservoir areas to free-flowing river reaches as part of the Proposed Project would have a beneficial effect on water temperature in the Hydroelectric Reach and the Middle Klamath River to the confluence with the Salmon River (Potential Impact 3.2-1) and chlorophyll-a and algal toxins in the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary (Potential Impact 3.2-12). Long-term increases in suspended material (Potential Impact 3.2-6 and 3.2-7) and nutrients (Potential Impact 3.2-8) due to the lack of continued interception by the Lower Klamath Project dams under the Proposed Project would have no significant impact, since the increases were relatively small compared to background conditions. The beneficial effect of restoration, flow enhancement, and water quality improvement projects on suspended materials and nutrients would potentially further reduce the relatively small long-term increases from the Proposed Project and improve water quality conditions downstream of the restoration, flow enhancement, and water quality improvement projects. As a result, the combined effect of the Proposed Project and these restoration, flow enhancement, and water quality improvement projects would be beneficial for water quality, especially for water temperature and chlorophyll-a and algal toxins. The restoration, flow enhancement, and water quality improvement projects would increase the amount of cold water flowing in the river improving water temperature conditions for salmonids, while the Proposed Project would improve water temperature by returning more natural seasonal and daily variations. In combination with restoration, flow enhancement, and water quality improvement projects, the Proposed Project would help to offset the effects of climate change on late summer/fall water temperatures, where climate change is expected to increase these temperatures in the Klamath Basin on the order of 1.8–5.4°F between 2012 and 2061 (Bartholow 2005 Perry et al. 2011).

Increases in river flows from restoration, flow enhancement, and water quality improvement projects would also be beneficial for water quality by diluting chlorophyll-a and algal toxins concentrations, while the Proposed Project would decrease high seasonal chlorophyll-*a* concentrations and periodically high algal toxin concentrations by eliminating the reservoir environment that currently supports growth conditions for toxin-producing nuisance blue-green algal species such as *Microcystis aeruginosa.* In combination with restoration, flow enhancement, and water quality improvement projects, the Proposed Project would help to offset the effects of climate change on the frequency of algal blooms, where climate change is generally expected to affect water quality through increased runoff and the associated potential for algal blooms (Michalak 2016).

Overall, the Proposed Project, in combination with restoration, flow enhancement, and water quality improvement projects, would result in beneficial cumulative effects on water quality.

Significance

Beneficial cumulative effects

Potential Cumulative Impact 3.24-2 Short-term increases in suspended sediments under the Proposed Project in combination with the 2017 court-ordered flushing and emergency dilution flows.

Formal consultation of the NMFS and USFWS 2013 Joint Biological Opinion (2013 BiOp) (NMFS and USFWS 2013) for the USBR Klamath Irrigation Project was reinitiated in 2017 to improve management of *Ceratanova Shasta (C. Shasta)* infection among coho salmon in the Klamath River. Until formal consultation is completed and a new biological opinion (BiOp) is issued, USBR is required to manage *C. Shasta* by releasing additional winter-spring surface flushing flows and deep flushing flows, as well as emergency dilution flows (U.S. District Court 2017). The flushing and emergency dilution flow requirements are in addition to 2013 BiOp flow requirements, which remain in effect until formal consultation is completed. During the period when the Proposed Project would occur, the 2017 flow requirements (i.e., 2013 BiOp Flows plus the 2017 court-ordered flushing and emergency dilution flows) or the to-be-determined new BiOp flow requirements may be in effect since USBR's consultation with NMFS and USFWS on the 2013 BiOp Flows for the Klamath Irrigation Project is currently underway and is expected to be completed by August of 2019 (see also Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*). At this time, estimates of flows that will be required under the future Klamath Irrigation Project biological opinion are speculative, so they are not included in hydrologic modeling. Potential new BiOp flow requirements under the Proposed Project are speculative in part because the fish disease conditions that prompted the flushing and emergency dilution flow requirements would be reduced due to increased dispersal of spawners and carcasses, transport of bedload, and establishment of variable flows, even if infection is not eliminated (see Section 3.3.5.5 *Fish Disease and Parasites*). Thus, it is not clear whether flushing and emergency dilution flow requirements would continue under a new BiOp after dam removal. It is also not clear if the prior location of Iron Gate Dam would remain as the compliance point if the flushing and emergency dilution flows continued. However, the 2017 flow requirements are the most reasonable assumption for conditions until formal consultation is completed and a new BiOp is issued. This is different from the existing conditions flow requirements, since the flushing flow requirements were imposed after issuance of the Notice of Preparation.

The 2017 flow requirements for the USBR Klamath Irrigation Project are generally the same as the 2013 BiOp Flows analyzed under the individual resource sections for the Proposed Project, but they also include new flushing and emergency dilution flows based on the management guidance from *Measures to Reduce Ceratanova Shasta Infection of Klamath River Salmonids: A Guidance Document* (Hillemeier et al. 2017; U.S. District Court 2017). The management guidance specifies surface and deep flushing flows downstream of Iron Gate Dam to dislodge and flush out polychaete worms attached to the streambed that host *C. Shasta*, and emergency dilution flows downstream of Iron Gate Dam to reduce disease conditions in the Klamath River, if specific disease criteria are exceeded. In the 2013 BiOp, Iron Gate Dam is the compliance point for flow requirements. Iron Gate Dam is assumed to be the compliance point for the 2017 court-ordered flushing and emergency dilution flows since the injunction specifies the flushing and emergency flows be modeled on the management guidance and the management guidance specifies the flows occur downstream of Iron Gate Dam. Surface flushing flows of at least 6,030 cfs for a 72-hour period are required to be met by USBR every year between November 1 and April 30 to scour riverbed sediments (i.e., scour fine sediment from approximately 20 to 30 percent of the surface of the streambed). USBR is also required to release deep flushing flows averaging at least 11,250 cfs over a single 24-hour period between February 15 and May 31 every other year to scour fine sediment from between gravels and cobbles (i.e., armor layer) on the streambed and potentially move individual armor layer particles, if such a flow does not occur naturally. Deep flushing flows were first required in 2017, so according to the court order they would be required again in 2019 and 2021. The timing of surface and deep flushing flows within the specified period is left to the discretion of USBR, but the USBR is required to coordinate with the parties[175] specified in the U.S. District Court case regarding the timing and magnitude of the flushing flows. Emergency dilution flows of 3,000 cfs (potentially increasing to 4,000 cfs) up to a maximum volume of 50,000 acre-feet may also be required to be released by USBR from Iron Gate Dam between April 1 to June 15, if fish disease thresholds in the Klamath River downstream of Iron Gate Dam are exceeded. USBR, as part of their management of the Klamath Irrigation Project, is required to reserve the 50,000 acre-feet in case release is needed.

This Potential Cumulative Impact examines whether the Proposed Project in combination with the 2017 flow requirements (i.e., 2013 BiOp Flows plus the court-ordered flushing and emergency dilution flows) potentially would have a short-term significant cumulative effect on suspended sediments, with the incremental contribution of the Proposed Project being cumulatively considerable. As discussed in Potential Impact 3.2-3, the Proposed Project would result in a significant and unavoidable short-term impact on suspended sediment by causing suspended sediment to be greater than 100 mg/L over a continuous two-week period (i.e., the suspended sediment significance criteria), especially during the reservoir drawdown period from November to March. This impact evaluates the potential change in significance to that impact in light of the 2017 flow requirements.

Modeling of reservoir drawdown flows during representative water years indicates that the flow at Iron Gate Dam under the Proposed Project would meet the annual surface flushing requirements in all water year types except dry, but reservoir drawdown flows would only meet the biennial deep flushing flows during the above normal water year and two of the three representative wet water years (Figures 3.24-1 and 3.24-2). In years that reservoir drawdown flows meet flushing flow requirements, drawdown flows would mobilize the streambed sediments in the Middle Klamath River downstream of Iron Gate Dam to the threshold expected for dislodging and flushing the polychaete worms involved in fish disease. Suspended sediment concentrations (SSCs) estimated as part of the Proposed Project (Potential Impact 3.2-3) would include the mobilization of these streambed sediments downstream of Iron Gate Dam, and there would be no cumulative increase in suspended sediment from the combination of the Proposed Project and the 2017 flow requirements because the latter would not be required.

[175] Parties refer to Yurok Tribe, Pacific Coast Federation of Fishermen's Associations, Institute for Fisheries Resources, Klamath Riverkeeper, Hoopa Valley Tribe, National Marine Fisheries Service, Klamath Water Users Association, Sunnyside Irrigation District, Ben DuVal, Klamath Drainage District, Klamath Irrigation District, and Pine Grove Irrigation District.

In years where reservoir drawdown flows would not meet the magnitude or duration of flushing flow requirements (Figures 3.24-1 and 3.25-2), surface and/or deep flushing flow releases may still be required. These flushing flows would mobilize more sand, silt, and clay sized sediment downstream of Iron Gate Dam than would occur under the Proposed Project, resulting in higher SSCs downstream of Iron Gate Dam. Additionally, the flushing flows would likely need to be released from Keno Dam under the Proposed Project since J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams would not be available to release these flows, so more sediment and increases in SSCs would potentially occur throughout the Hydroelectric Reach. Flushing flows may also increase SSCs by re-wetting and mobilizing some of the reservoir sediments that were not transported during reservoir drawdown. The flushing flows are within the range of flows modeled under the Proposed Project, so increases in SSCs under flushing flows would be within the range of SSCs modeled under the Proposed Project. While flushing flows would only occur for 72 hours (surface flushing) or 24 hours (deep flushing), they may prolong the duration of SSCs exceeding the significance criteria (i.e., 100 mg/L for a continuous two week period) compared to under the Proposed Project drawdown flows alone, if flushing flows occur when the drawdown flows are nearly or completely finished (November to March). The incremental increase in SSCs due to flushing flows are unlikely to increase the duration of SSCs above 100 mg/L for an entire two-week period since the duration of the flushing flows is 72 hours or less, but SSCs greater than 100 mg/L due to the Proposed Project that would last for less than two weeks may occur for two weeks or slightly more with the flushing flows. There are one to two months when flushing flows may increase SSCs outside of the Proposed Project reservoir drawdown period since surface flushing flows potentially would occur until April 30 and deep flushing flows potentially would occur until May 31. Thus, there would be the potential for a cumulative short-term increase in SSCs in the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary from the combined effect of the Proposed Project and the 2017 flow requirements in water years when the Proposed Project reservoir drawdown flows do not meet the surface and/or deep flushing flow requirements.

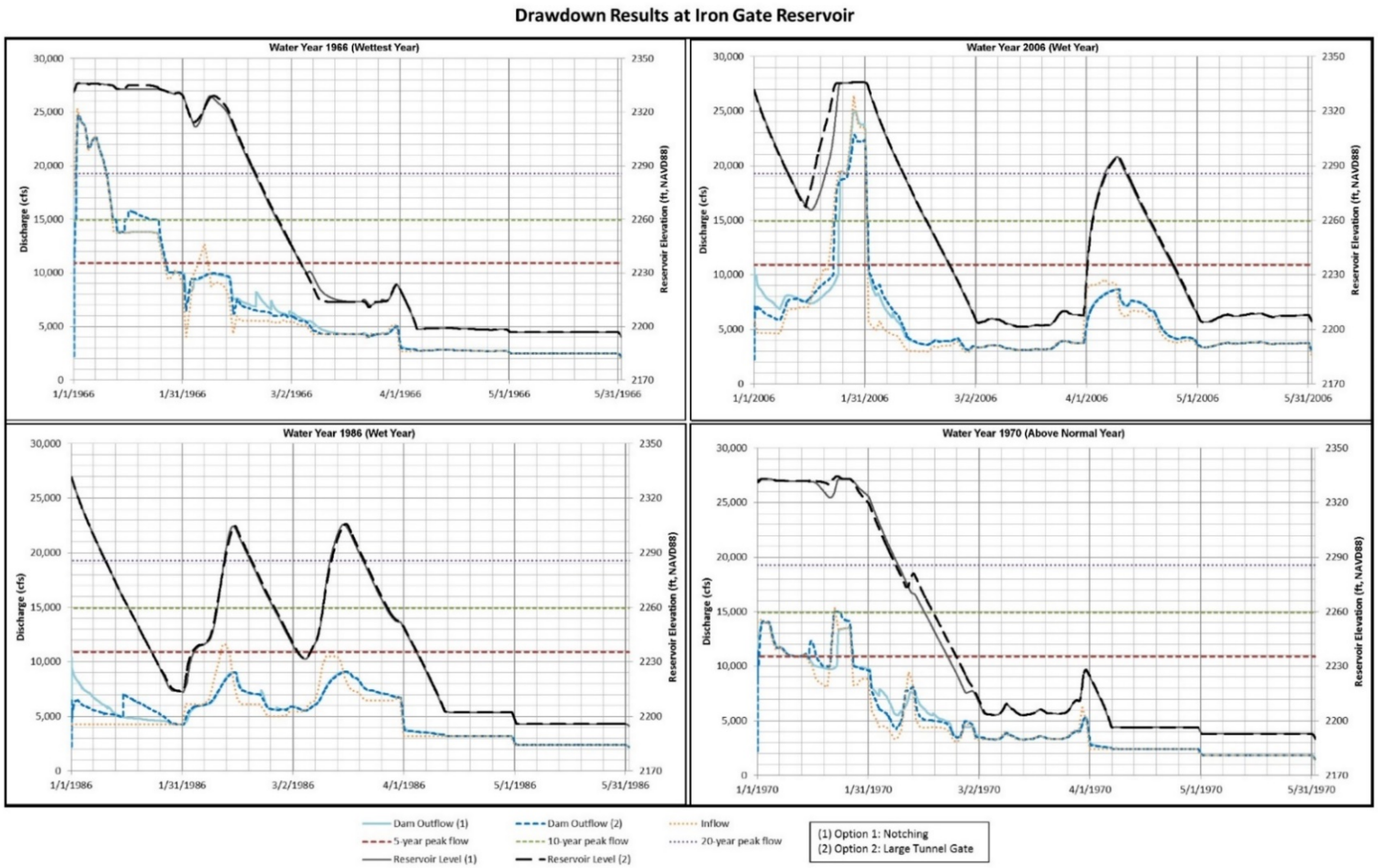

Figure 3.24-1. Proposed Project Modeled Drawdown Flow Downstream of Iron Gate Dam and Iron Gate Reservoir Elevation for Representative Wet and Above Normal Water Year Types. Dam Outflow Option 2 (Large Tunnel Gate) is included in the Proposed Project. Dam Outflow Option 1 (Notching) is presented in the Definite Plan for comparison purposes only; KRRC is not proposing notching as the preferred plan for dam demolition. Surface annual flushing flows of at least 6,030 cfs for 72 hours would occur between November 1 and April 30, while deep flushing flows of at least 11, 250 cfs for 24 hours would occur every other year starting in 2017 (i.e., odd numbered years) between February 15 and May 31.

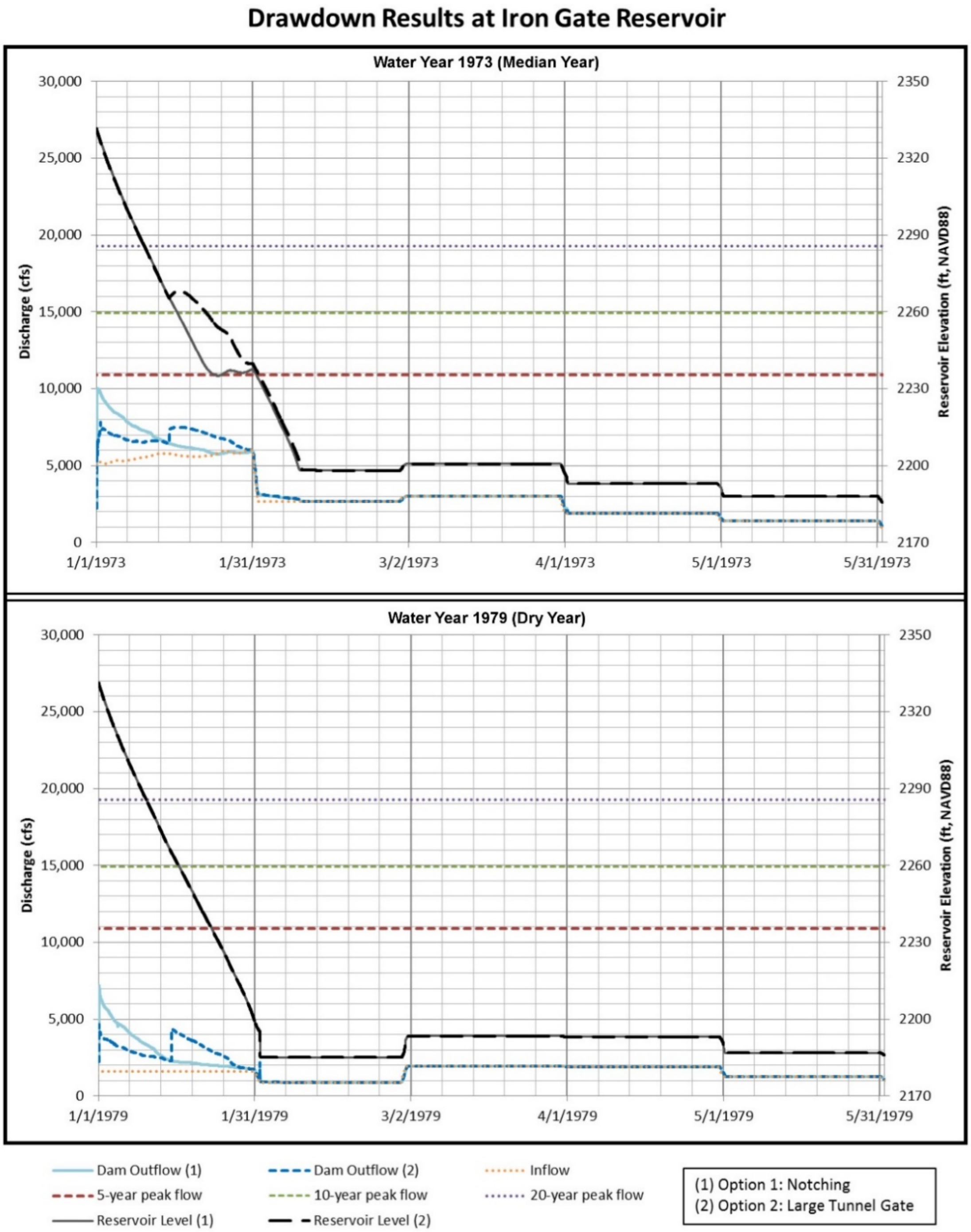

Figure 3.24-2. Proposed Project Modeled Drawdown Flow Downstream of Iron Gate Dam and Iron Gate Reservoir Elevation for Representative Median and Dry Water Year Types. Dam Outflow Option 2 (Large Tunnel Gate) is included in the Proposed Project. Dam Outflow Option 1 (Notching) is presented in the Definite Plan for comparison purposes only; KRRC is not proposing notching as the preferred plan for dam demolition. Surface annual flushing flows of at least 6,030 cfs for 72 hours would occur between November 1 and April 30, while deep flushing flows of at least 11, 250 cfs for 24 hours would occur every other year starting in 2017 (i.e., odd numbered years) between February 15 and May 31.

Emergency dilution flows may be required under the 2017 flow requirements between April 1 to June 15 regardless of reservoir drawdown flows from the Proposed Project, since emergency dilution flows are based on disease thresholds in the Klamath River downstream of Iron Gate Dam. If required, emergency dilution flows (3,000 to 4,000 cfs) are unlikely to increase SSCs and/or durations due to re-wetting and mobilization of remaining floodplain and reservoir sediment deposits, because they are below the thresholds recognized for coarse and fine particle entrainment (see USBR 2012). Additionally, it is unlikely that emergency dilution flows would be required in the months just following reservoir drawdown under the Proposed Project because periods of high SSCs (Potential Impact 3.2-3) and low dissolved oxygen (Potential Impact 3.2-9) in reaches of the Klamath River downstream of Iron Gate Dam during reservoir drawdown (November 1 to March 15) would limit periphyton establishment along the streambed following drawdown, which would also limit favorable habitat for the polychaete worm that hosts fish parasites (e.g., *C. shasta*) during April 1 to June 15 of the same year. Overall, exceedances of disease thresholds that would trigger emergency dilution flows would be unlikely In the short term, particularly in dam removal year 2, and thus there would be no cumulative impact due to an increase in SSCs from emergency dilution flows associated with the 2017 court-ordered flows.

Overall, the short-term combined impact of the Proposed Project and the 2017 flow requirements (i.e., 2013 BiOp plus court-ordered flushing and emergency dilutions flows) would result in a cumulative increase in the SSCs during water years when reservoir drawdown flows are less than the surface and/or deep flushing flows. The short-term cumulative increase in SSCs would not increase the magnitude of SSCs outside the range modeled for the Proposed Project, but the cumulative effect may increase the duration that SSCs exceed the significance criterion in the Klamath River if flushing flows occur when the drawdown flows are nearly or completely finished. Thus, the Proposed Project combined with the 2017 flow requirements would potentially have a short-term cumulatively considerable impact in the in the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary.

There are no long-term cumulative water quality impacts from the Proposed Project's sediment and sediment-related (i.e., sediment-associated nutrients, oxygen demand, and inorganic and organic contaminants) impacts and the 2017 flow requirements (Potential Impacts 3.2-6, 3.2-7, 3.2-9, 3.2-11, 3.2-14, and 3.2-15). SSCs in the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary are predicted to resume background levels by the end of post-dam removal year 1 under all water year types, especially with revegetation of the reservoir sediments immediately following dam removal which would stabilize the sediment from erosion due to rainfall (USBR 2012). As such, the combined impact of the Proposed Project and the 2017 flow requirements would not be cumulatively considerable.

Significance

Cumulatively considerable in the short term

No significant cumulative impact in the long term

Potential Cumulative Impact 3.24-3 Long-term water quality effects of the Proposed Project in combination with forest and wildfire management activities. In the water quality Area of Analysis, anticipated forest and wildfire management project activities include commercial and non-commercial thinning in stands for forest health and fuel reduction, using prescribed fire, creating strategic fuel breaks, implementing fuel treatments including under-burning and pile burning, revegetating areas to accelerate the development of mature forest, enhancing meadow conditions, improving water temperature and sediment conditions in streams, modifying road conditions, and increasing recreational opportunities. The main water quality parameters potentially adversely impacted by these activities would be water temperature, since vegetation removal allows more solar radiation to reach streams and the surrounding floodplain surfaces, and suspended sediment due to vegetation removal, prescribed burns, fuel treatments, and road construction and usage increasing erosion. The North Coast Regional Water Quality Control Board's Forest Activities Program issues waste discharge requirements and general waivers with terms and conditions to address the potential water quality problems potentially associated with a range of forest management activities on private and on US Forest Service lands (North Coast Regional Board 2018c). Reasonably foreseeable forest and wildfire management projects within or near the water quality Area of Analysis are included in Table 3.24-1.

The Proposed Project would have either a beneficial effect (Potential Impact 3.2-1) or result in no significant impact (Potential Impact 3.2-2) on water temperature in the Area of Analysis. Suspended sediment impacts from the Proposed Project would be significant and unavoidable in the short term due to increases in suspended sediment as reservoir sediments trapped behind the Lower Klamath Project dams are released (Potential Impact 3.2-3), but the other short-term and long-term impacts and potential impacts of the Proposed Project on suspended sediment in the Area of Analysis would be beneficial, not significant, or not significant with mitigation (Potential Impacts 3.2-4 through 3.2-6). Most notably, there would be no significant impact in the long term on suspended sediment concentrations from releases of reservoir sediments currently trapped by the Lower Klamath Project dams or the lack of continued interception and retention of suspended material behind the Lower Klamath Project dams. Suspended sediment concentrations in the Klamath River are expected to return to background levels by the end of post-dam removal year 1 and the long-term annual increase in suspended sediments downstream of Iron Gate Dam would be relatively small (approximately 3.4 percent) compared to the cumulative average annual sediment load from the Klamath Basin.

The Proposed Project and forest and wildfire management activities would not have a significant cumulative impact on water quality, since the cumulative magnitude of changes to water quality would not be anticipated to exceed the water quality significance criteria or impact designated beneficial uses. There would be no significant cumulative impact during drawdown of the Lower Klamath Project reservoirs and the Proposed Project impacts associated with drawdown (e.g., Potential Impact 3.2-3 and Potential Impacts 3.2-7, 3.2-9, 3.2-13, 3.2-14), because drawdown would occur during November through March when forest and wildfire management activities (e.g., prescribed burns or commercial logging) would be limited. Under the Proposed Project, dam removal also would result in a less than significant increase in inorganic (mineral) and organic (algal-derived) suspended material in the Klamath River due to the lack of continued interception and retention by the Lower Klamath Project dams (Potential Impact 3.2-5 and 3.2-6). While some forest and wildfire management activities would potentially increase water temperature and suspended sediment in streams due to removal of vegetation cover and temporary or permanent road construction and usage for tree removal (i.e., logging), other activities would potentially improve water quality conditions by revegetating areas, enhancing riparian cover along meadow streams, and decommissioning or downgrading roads to reduce suspended sediment delivery to streams. As a result, the net effect from the anticipated forest and wildfire management activities would be less than significant and there would be no significant cumulative impact from the Proposed Project and forest and wildfire management activities.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-4 Short-term and long-term water quality effects of the Proposed Project in combination with wildfires.

Wildfires regularly occur within the Klamath Basin with multiple fires occurring in 2016 through 2018 (see Table 3.24-1). Under climate change, forests will be more susceptible to extreme wildfires, with an almost 50 percent increase in the frequency of extreme wildfires that burn over approximately 25,000 acres, and a 77 percent increase in the average area burned statewide by the end of the century (Bedsworth et al. 2018). Within the water quality Area of Analysis, wildfires could potentially impact water quality by reducing the forest or vegetation cover around streams. Water temperature may increase due to more solar radiation reaching the stream or sediments from burn areas depositing in streams, creating shallower streams, and resulting in more rapid warming of the streams. In the short term and long term, the Proposed Project would decrease Klamath River water temperatures in the Hydroelectric Reach and Middle Klamath River from Iron Gate Dam to the confluence with the Salmon River during the late summer/fall compared with existing conditions (Potential Impact 3.2-1), which would help to offset potential increases in water temperatures in wildfire burn areas, should they occur within these reaches in the water quality Area of Analysis. This would be a benefit of the Proposed Project in combination with wildfires. The Proposed Project would have no effect on water temperatures for the Middle Klamath River downstream from the Salmon River, the Lower Klamath River, and the Klamath River Estuary in the short term or the long term, thus there would be no cumulative impact on water temperature for the Proposed Project combined with wildfires.

Wildfires could potentially impact water quality by increasing SSCs due to increased erosion in burn areas. In the short term, the increase in suspended sediment from wildfires would be expected to be small compared to the Proposed Project impacts on suspended sediment during reservoir drawdown (Potential Impacts 3.2-3 and 3.2-4) and in comparison to natural sediment conditions in the Klamath River (USBR 2012). However, a late-season (e.g., November) wildfire during dam removal year 1 or 2 that burns the landscape near or within the water quality Area of Analysis and is followed by heavy rainstorms would potentially result in a short-term cumulative increase in the SSCs. Erosion from heavy rains on a burned area from a late-season wildfire could increase SSCs during the initial drawdown of Copco No. 1 Reservoir in dam removal year 1 or during the late-fall/early winter period in dam removal year 2 and result in SSCs exceeding the significance criteria (i.e., 100 mg/L for a continuous two week period) for a longer duration than under the Proposed Project alone. However, the short-term cumulative increase in SSCs from a late-season wildfire followed by heavy rains would not be likely to increase the magnitude of SSCs outside the range modeled for the Proposed Project. Given that the Proposed Project exceeds significance criteria for SSCs, and because of the potential for an extended duration of elevated SSCs in the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary from the combination of the Proposed Project and wildfires, this short-term impact is conservatively assessed as cumulatively considerable.

In the long term, SSCs under the Proposed Project are expected to resume natural background levels by the end of post-dam removal year 1 (USBR 2012) and there would be no significant impact on SSCs in the Hydroelectric Reach, Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment due to the release of sediments currently trapped behind the Lower Klamath Project dams (Potential Impact 3.2-3). While wildfires potentially would increase SSCs occasionally in the long term if eroded sediments from a burn area during heavy rain entered the Klamath River, there would be no cumulative effect on water temperature from the Proposed Project and wildfires since the SSCs would have resumed natural background levels.

Significance

Cumulatively considerable in the short term

No significant cumulative impact in the long term

Potential Cumulative Impact 3.24-5 Long-term water quality effects of the Proposed Project in combination with cannabis cultivation projects.

Cannabis cultivation related projects within the water quality Area of Analysis and the Klamath Basin were assessed to determine if there would be a cumulative effect with the Proposed Project. Cannabis cultivation projects could potentially impact multiple water quality parameters, including water temperature as flow diversions for cultivation reduce stream flows and result in more rapid warming and higher water temperatures; suspended sediment from stormwater runoff of cultivated land; nutrients from stormwater runoff containing fertilizers; chlorophyll-a and algal toxins due to nutrients in stormwater runoff promoting additional phytoplankton or periphyton growth; and inorganic and organic contaminants from pesticide application. While there are potential water quality impacts from cannabis cultivation, many of those projects are part of the environmental setting (i.e., they existed at the time of issuance of the Notice of Preparation [2016]) and numerous regulatory agencies manage the water quality impacts from cannabis cultivation. Water quality impacts from these previously existing projects are represented in the water quality environmental setting (see Section 3.2.2 *[Water Quality] Environmental Setting* for more details) even though the existing projects are only now being permitted due to the recent legalization of cannabis cultivation. Additionally, the North Coast Regional Water Quality Control Board Cannabis Cultivation Waste Discharge Regulatory Program (North Coast Regional Board 2018b), the California Department of Food and Agriculture CalCannabis Cultivation Licensing, the California Department of Pesticide Regulation, and other agencies are regulating cannabis cultivation, including water quality and waste discharge requirements. New or existing permitted cannabis cultivation projects would be required to adhere to water quality regulations and implement project-specific measures to minimize or reduce to less than significant potential impacts to water quality. Project-specific measures detailed for several existing cannabis cultivation projects include relocating cultivation away from a stream, limiting the timing of diversions from streams, replacing unpermitted wells with permitted wells, and using drip irrigation systems to minimize water use. As such, cannabis cultivation projects would be expected to have a less than significant impact on water quality in the Area of Analysis.

Depending on the reach of the Klamath River and the time scale (short-term or long-term) being analyzed, the Proposed Project would have a beneficial effect, no significant impact, or no significant impact with mitigation for the water quality parameters evaluated, including water temperature (Potential Impacts 3.2-1 and 3.2-2), suspended sediment (Potential Impacts 3.2-3 through 3.2-6), nutrients (Potential Impacts 3.2-7 and 3.2-8), chlorophyll-a and algal toxins (Potential Impact 3.2-12), and inorganic and organic contaminants (Potential Impacts 3.2-13 through 3.2-16). However, the short-term increases in suspended sediment as reservoirs sediments trapped behind the Lower Klamath Project dams are released (Potential Impact 3.2-3), would be significant and unavoidable. Since cannabis cultivation would be required to adhere to these regulations and implement project-specific measures to minimize or reduce to less than significant potential water quality impacts, the combined effect of the Proposed Project and cannabis cultivation projects not result in further impacts to water quality. Thus, there would be no significant cumulative water quality impact due to the Proposed Project.

Significance
No significant cumulative impact

Potential Cumulative Impact 3.24-6 Long-term water quality effects of the Proposed Project in combination with grazing and other agricultural projects.
Grazing and other agricultural projects may increase suspended sediment within streams due to soil disturbance and increased erosion; may increase nutrients in streams due to stormwater runoff from grazing or agricultural areas containing either livestock waste (grazing) or fertilizers (agriculture); may decrease dissolved oxygen due to the biological oxygen demand from stormwater runoff containing livestock waste (grazing) or fertilizers (agriculture); and may increase chlorophyll-a and algal toxins due to nutrients in stormwater runoff promoting additional phytoplankton or periphyton growth.

Any existing grazing or agricultural impacts on the Area of Analysis are accounted for in the analysis of the existing conditions. Most of the anticipated grazing and agricultural projects would not have the potential to impact water quality conditions in the water quality Area of Analysis because they would not occur within or upstream of the water quality Area of Analysis, including within tributaries of the Klamath River in California, where sediment, nutrients, and biological oxygen demand in runoff from grazing or agricultural lands could potentially influence water quality conditions within the water quality Area of Analysis (Table 3.24-1). Reasonably foreseeable grazing or agricultural projects located downstream of the Project Boundary in California, but still near the water quality Area of Analysis, are included in Table 3.24-1.

Grazing and agricultural projects would incorporate project-specific measures to reduce potential water quality impacts, including storm water management, streambank setbacks, or exclusionary livestock fencing. Grazing (and other agricultural projects) are required to meet the requirements of the non-point source discharge policy, the prohibition against unpermitted discharges, and the North Coast Regional Water Quality Control Board's Agricultural Lands Discharge Program. These require compliance with best management practices designed to meet state water quality requirements. (North

Coast Regional Board 2018a). Grazing and agricultural projects implementing such project-specific measures would be expected to have a less than significant impact on water quality in the Area of Analysis. Assuming grazing and agricultural projects implement project-specific measures to reduce water quality impacts, the combined effect of the Proposed Project and grazing and agricultural projects would not result in further impacts to water quality and there would be no significant cumulative water quality impact due to the Proposed Project and these grazing and agricultural projects.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-7 Long-term water quality effects of the Proposed Project in combination with mining projects.

Mining projects within the water quality Area of Analysis and the Klamath Basin were evaluated to determine if there would be a cumulative effect with the Proposed Project. Mining projects may impact multiple water quality parameters, including increasing suspended sediment and inorganic or organic contaminants. Most of the anticipated mining projects are not within the water quality Area of Analysis or the vicinity of the mainstem Klamath River (Table 3.24-1) and they would be unlikely to impact water quality conditions within the Area of Analysis. Projects in the vicinity of the water quality Area of Analysis include the Brooks Mine, an existing mine located approximately five miles south of the Klamath River, near Humbug Creek, California. Any existing mining operations impacts on the Area of Analysis are accounted for in the analysis of the existing conditions. While there are potential water quality impacts from mining, these projects would be required to adhere to local, state, and/or federal mining regulations to protect water quality and implement project-specific measures to manage and reduce potential water quality impacts. Storm water management, waste discharge permits, and monitoring would all likely be necessary for any mining projects adjacent to water ways. As mining projects are required to implement such measures to reduce water quality impacts, the combined effect of the Proposed Project and mining would not result in further impacts to water quality. As such, there would be no significant cumulative water quality impact due the Proposed Project and mining projects.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-8 Long-term water quality effects of the Proposed Project in combination with stream-crossing infrastructure projects.

The potential cumulative effects of the Proposed Project and infrastructure projects with stream crossings on water quality were evaluated. Most of the anticipated infrastructure projects with stream crossings projects are not within the water quality Area of Analysis or the vicinity of the mainstem Klamath River (Table 3.24-1) and they would be unlikely to impact water quality conditions within the Area of Analysis. One infrastructure project with a proposed crossing of the Klamath River occurs outside of the Area of Analysis, but it is potentially significant enough to merit consideration for potential water quality impacts in the Klamath River that may flow into the Area of Analysis in California. In Oregon, the Jordan Cove Energy Project/Pacific Connector Gas Pipeline is proposed to cross the Klamath River near Klamath Falls. As it has been proposed, the pipeline would cross the Klamath River by drilling through the bedrock beneath the river.

The construction and operation of the pipeline potentially could impact water quality in the Klamath River, with potential impacts to suspended sediment and inorganic and organic contaminants, especially during construction. The time of construction is highly uncertain based on the project history; it would be speculative to assume that construction-related water quality impacts from the pipeline project would occur during the periods when short-term Proposed Project water quality impacts would occur. However, construction-related impacts that would potentially impact suspended sediment or inorganic and organic contaminants likely would be mitigated to less than significant by implementing BMPs. Additionally, the Project would be required to adhere to local, state, and/or federal regulations to protect water quality, including a Clean Water Act Section 401 Water Quality Certification from the Oregon Department of Environmental Quality that would minimize and mitigate potential long-term water quality impacts. Thus, there would be no significant cumulative water quality impacts due to the combined effect of the Proposed Project and the pipeline project.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-9 Short-term water quality effects of the Proposed Project in combination with KHSA Interim Measure 16 Water Diversion Project.

Under the KHSA Interim Measure 16 (IM 16), PacifiCorp would seek to eliminate three screened diversions (the Lower Shovel Creek Diversion [7.5 cfs], Upper Shovel Creek Diversion [2.5 cfs], and Negro Creek Diversion [5 cfs]) from Shovel and Negro creeks and would seek to modify its water rights to move the points of diversion from Shovel and Negro creeks to the mainstem Klamath River (Table 2.7-17). The screened diversions would be removed prior to dam removal. The intent of this measure is to increase flows in Shovel and Negro creeks and to increase the quality and amount of suitable habitat for aquatic species within these tributaries without diminishing PacifiCorp's water rights. The potential for sediments to enter the water during screen removal activities is minimal if the diversions are individual pump intakes. If the diversions are larger, concrete structures, the impacts would have a greater magnitude and a longer duration, but the impacts would still be short-term and due to construction/deconstruction activities. Impacts to water quality from suspended material would be minimized or eliminated through the implementation of BMPs for construction activities stipulated during permitting of IM 16. Additionally, IM 16 would be undertaken prior to dam removal, so any disturbed sediments would be trapped by Copco No. 1 Reservoir and not transferred downstream to the Klamath River prior to dam removal. The diversions would not be likely to affect other aspects of short-term or long-term water quality in the mainstem Klamath River since the water rights are relatively small (7.5 cfs, 2.5 cfs, and 5 cfs) compared to seasonal low flows in the mainstem upstream of Copco No. 1 Reservoir (typically greater than 800 cfs). The combined effect of the Proposed Project and IM16 would not result in further impacts to water quality. As such, there would be no significant cumulative water quality impact due the Proposed Project and IM 16.

Significance

No significant cumulative impact

3.24.3 Aquatic Resources

The geographic scope for cumulative aquatic resource effects is the same as the Area of Analysis for aquatic resources, as described in detail in Section 3.3.*1 [Aquatic Resources] Area of Analysis*. The geographic scope extends across five study reaches of the Klamath River including the Upper Klamath River and Connected Waterbodies, the Hydroelectric Reach in the Upper Klamath Basin, the Middle Klamath River from Iron Gate Dam to the confluence with the Trinity River, the Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment (Figure 3.3-1).

Existing conditions for aquatic resources in the Area of Analysis are described in Section 3.3.2 *[Aquatic Resources] Environmental Setting*. The aquatic species (Section 3.3.2.1 *Aquatic Species*); physical habitat in the waterbodies (Section 3.3.2.2 *Physical Habitat Descriptions*); and important factors affecting aquatic resources that the Proposed Project would influence (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*), are also detailed. Section 3.3.2 *[Aquatic Resources] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, aquatic resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of aquatic resource area effects (Section 3.3). The non-project activity types evaluated for potential cumulative impacts on aquatic resources shown below are those that would be likely to result in aquatic habitat alteration, changes in surface flows, and changes in water quality (water temperature, suspended sediment). While wildfire is a natural occurrence, under climate change more frequent and intense wildfires are reasonably foreseeable (Bedsworth et al. 2018) and thus wildfires are also evaluated for potential cumulative impacts on aquatic resources. The non-project activity types (plus wildfires) are included in Table 3.24-1.

Significance criteria for cumulative aquatic resources impacts are the same as defined in Section 3.3.3 *[Aquatic Resources] Significance Criteria*.

Potential Cumulative Impact 3.24-10 Long-term effects on aquatic resources from the Proposed Project in combination with restoration, flow enhancement, and water quality improvement projects.

As described in Section 3.3.5 *[Aquatic Resources] Potential Impacts and Mitigation*, the Proposed Project would increase habitat quantity and quality for aquatic resources. Other aquatic habitat restoration, flow enhancement, and water quality improvement projects along the Klamath River and its tributaries (creeks and rivers) are also anticipated to directly improve conditions for aquatic species (especially for juvenile salmonids rearing during winter), through the placement of off-channel habitat features, floodplain restoration, incorporation of large wood into tributaries to the Klamath River, increases in stream flow, and improved water quality (Table 3.24-1), thus having a beneficial effect. For example, the proposed relocation of water diversions from Shovel and Negro creeks to the mainstem Klamath River would increase the quality and amount of suitable habitat for aquatic species within these tributaries. Additionally, USBR's annual restoration funding of approximately $500,000 provided as part of its Klamath Irrigation Project operations benefits coho salmon through habitat improvements. Restoration funding is described in the 2013 BiOp and is focused on activities that provide benefits to SONCC coho salmon and those aspects of their designated critical habitat in the Klamath Basin that are most likely to be affected by Klamath Irrigation Project operations. Since 2013 many coho salmon fish passage and habitat restoration projects have been funded and implemented in the Mid- and Lower Klamath River. The Proposed Project, in combination with restoration, flow enhancement, and water quality improvement projects, would result in beneficial cumulative effects on aquatic resources.

Significance

Beneficial cumulative effects

Potential Cumulative Impact 3.24-11 Short-term increases in suspended sediments on aquatic resources under the Proposed Project in combination with 2017 court-ordered flushing and emergency dilution flows.

As discussed in Potential Cumulative Impact 3.24-2, the short-term combined impact of the Proposed Project and the 2017 court-ordered flow requirements (i.e., 2013 BiOp plus the court ordered flushing and emergency dilutions flows) would result in a cumulative increase in the suspended sediment concentrations during water years when reservoir drawdown flows are less than the surface and/or deep flushing flows. The 2017 court-ordered flushing flows are released from Iron Gate Dam for the purpose of disrupting the nidus downstream of Iron Gate Dam and reducing disease risk. High concentrations of suspended sediment and bedload sediment released during dam removal year 2 is anticipated to effectively scour and disrupt the periphyton intermediate host of the key fish diseases, and thus flushing flows and emergency dilution flows are highly unlikely to be required during the same period of impacts from the Proposed Project. In addition, the incremental effect of the increased suspended sediment on aquatic resources would be dwarfed by the substantial sediment volumes of sediment predicted to occur (described in detail in Appendix E). Therefore, the impacts predicted for aquatic resources under the Proposed Project (described in Section 3.3.5.9 *Aquatic Resource Impacts*) are no lesser, nor higher, when considered cumulatively with the 2017 court-ordered flushing and emergency dilution flows.

Significance

No significant cumulative impact in the short term

Potential Cumulative Impact 3.24-12 Long-term effects on aquatic resources from the Proposed Project in combination with forest and wildfire management activities.

The cumulative effect of the Proposed Project and the multiple forest and wildfire management projects within the aquatic resources Area of Analysis was evaluated. The forest and wildfire management project activities include commercial and non-commercial thinning in stands for forest health and fuel reduction, using prescribed fire, creating strategic fuel breaks, implementing fuel treatments including under-burning and pile burning, revegetating areas to accelerate the development of mature forest, enhancing meadow conditions, improving water temperature and sediment conditions in streams, modifying road conditions, and increasing recreational opportunities. The main water quality parameters related to aquatic resources (see Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*) that would be potentially adversely impacted by these activities would be water temperature as vegetation removal allows more solar radiation to reach streams and the surrounding floodplain surfaces, and suspended sediment due to vegetation removal, prescribed burns, fuel treatments, and road construction and usage increasing erosion. The North Coast Regional Water Quality Control Board's Forest Activities Program issues waste discharge requirements and general waivers with terms and conditions to address the potential water quality problems potentially associated with a range of forest management activities on private and on USDA Forest Service lands. Forest and wildfire management projects within or near the aquatic resources Area of Analysis are included in Table 3.24-1.

The cumulative effect of the Proposed Project and forest and wildfire management activities would not have a significant impact on aquatic resources, since the cumulative magnitude of changes to water quality factors affecting aquatic habitat would not be anticipated to exceed the aquatic resource significance criteria. There would be no significant cumulative impact from drawdown of the Lower Klamath Project reservoirs and wildfire management activities, because drawdown would occur during November through March when forest and wildfire management activities (e.g., prescribed burns or commercial logging) would be limited. While some forest and wildfire management activities would potentially increase water temperature and suspended sediment in streams due to removal of vegetation cover and temporary or permanent road construction and usage for tree removal (i.e., logging), other activities would potentially improve long-term water quality and aquatic habitat conditions by revegetating areas, enhancing riparian cover along meadow streams, and decommissioning or downgrading roads to reduce suspended sediment delivery to streams. As a result, the net cumulative impact from the anticipated forest and wildfire management activities would be less than significant and there would not be a significant cumulative impact from the Proposed Project and forest and wildfire management activities.

Significance

No significant cumulative impact in the long term

Potential Cumulative Impact 3.24-13 Short-term and long-term effects on aquatic resources from the Proposed Project in combination with wildfires.

Wildfires also could potentially impact aquatic habitat through wildfire-related impacts to water temperature and increased suspended sediments (SSCs). In the short term and long term, the Proposed Project would decrease Klamath River water temperatures in the Hydroelectric Reach and Middle Klamath River from Iron Gate Dam to the confluence with the Salmon River during the late summer/fall compared with existing conditions (Potential Impact 3.2-1), which would help to offset potential increases in water temperatures in wildfire burn areas, should they occur within these reaches in the water quality Area of Analysis. This would generally be a benefit to aquatic resources. The Proposed Project would have no effect on water temperatures for the Middle Klamath River downstream from the Salmon River, the Lower Klamath River, and the Klamath River Estuary in the short term or the long term, thus there would be no cumulative impact on water temperature for the Proposed Project combined with wildfires.

As discussed in Potential Cumulative Impact 3.24-4, there would be a cumulatively considerable short-term impact of the Proposed Project on water quality due to increased SSCs during reservoir drawdown because the Proposed Project exceeds water quality significance criteria for SSCs, and because of the potential for an extended duration of elevated SSCs in the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary. However, short-term elevated SSCs during reservoir drawdown under the Proposed Project would result in no significant impact with mitigation for coho salmon critical habitat (Potential Impact 3.3-1), no significant short-term impact with mitigation for Chinook and coho salmon essential fish habitat (EFH) (Potential Impact 3.3-4), and no significant population impacts for multiple fish species within the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary (Potential Impacts 3.3-5 through 3.3-14). Further, the short-term cumulative increase in SSCs from a late-season (e.g., November) wildfire during dam removal year 1 or 2 that burns the landscape near or within the aquatic resources Area of Analysis and is followed by heavy rainstorms, would not be likely to increase the magnitude of SSCs outside the range modeled for the Proposed Project (see Potential Cumulative Impact 3.24-4) such that there would be no significant cumulative impact of the Proposed Project on aquatic resources in combination wildfires.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-14 Long-term effects on aquatic resources from the Proposed Project in combination with cannabis cultivation projects.

Cannabis-cultivation-related projects within the aquatic resources Area of Analysis and the Klamath Basin were assessed to determine if there would be a cumulative effect with the Proposed Project. Increased cannabis cultivation could potentially impact multiple water quality parameters that effect aquatic resources, including water temperature as flow diversions for cultivation reduce stream flows and result in more rapid warming and higher water temperatures; suspended sediment from stormwater runoff of cultivated land; and nutrients from stormwater runoff containing fertilizers. While there are potential water quality and thus aquatic resource impacts from cannabis cultivation, many of those projects are part of existing conditions and numerous regulatory agencies manage the impacts from cannabis cultivation. Additionally, the North Coast Regional Water Quality Control Board Cannabis Cultivation Waste Discharge Regulatory Program, the California Department of Food and Agriculture Cannabis Cultivation Licensing, the California Department of Pesticide Regulation, and other agencies are regulating cannabis cultivation, including water quality and waste discharge requirements. New or existing permitted cannabis cultivation projects would be required to adhere to water quality regulations and implement project-specific measures to reduce potential impacts to water quality (and thus aquatic resources). Project-specific measures detailed for several existing cannabis cultivation projects include relocating cultivation away from a stream, limiting the timing of diversions from streams, replacing unpermitted wells with permitted wells, and using drip irrigation systems to minimize water use: these changes are aimed at improving water quality over the existing condition. The potential impacts of new permitted cannabis cultivation projects would be addressed through the regulatory program, as well. As such, these changes in cannabis cultivation practices would have a less than significant impact on aquatic resources and the combination of the Proposed Project and these cannabis projects would not result in a significant cumulative impact to aquatic resources.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-15 Long-term effects on aquatic resources from the Proposed Project in combination with grazing projects and agriculture projects.

Grazing and agricultural projects may impact aquatic resources through an increase in suspended sediment within streams due to soil disturbance and increased erosion; an increase in nutrients in streams due to stormwater runoff from grazing areas containing livestock waste; and an decrease dissolved oxygen due to the biological oxygen demand from stormwater runoff containing livestock waste. Any existing grazing impacts on the Area of Analysis are accounted for the analysis of the existing condition. Additionally, most of the anticipated grazing and agricultural projects would not have the potential to impact water quality conditions in the aquatic resources Area of Analysis because they would not occur within or upstream of the Area of Analysis, including within tributaries of the Klamath River in California, where sediment, nutrients, and biological oxygen demand in runoff from grazing or agricultural lands could potentially influence water quality conditions within the Area of Analysis. Grazing projects located downstream of the Project Boundary in California, but still near the Area of Analysis, are included in Table 3.24-1.

Grazing projects would incorporate project-specific measures to reduce potential water quality impacts (and thus aquatic resource impacts), including storm water management, streambank setbacks, or exclusionary livestock fencing. Grazing (and other agricultural projects) are required to meet the requirements of the non-point source discharge policy, the prohibition against unpermitted discharges, and the North Coast Regional Water Quality Control Board's Agricultural Lands Discharge Program. These require compliance with best management practices designed to meet state water quality requirements. Grazing projects implementing such project-specific measures would have a less than significant impact on aquatic resources and the Proposed Project and these grazing projects would not result in a significant cumulative impact to aquatic resources.

Significance

No significant cumulative impact

3.24.4 Phytoplankton and Periphyton

The geographic scope for cumulative phytoplankton and periphyton effects is the same as the Area of Analysis for phytoplankton and periphyton, as described in detail in Section 3.4.1 *[Phytoplankton and Periphyton] Area of Analysis*. The geographic scope includes the Klamath River from the Hydroelectric Reach in the Upper Klamath Basin through the Lower Klamath River to its confluence with the Trinity River, the Klamath River Estuary, and the Pacific Ocean nearshore environment (Figure 3.4-1). The Upper Klamath River upstream of the Oregon-California state line (RM 214.1) is only considered to the extent that conditions in this reach influence phytoplankton and periphyton communities downstream in California.

Existing conditions for phytoplankton and periphyton in the Area of Analysis are described in Section 3.4.2 *[Phytoplankton and Periphyton] Environmental Setting*. Spatial and temporal trends in phytoplankton and periphyton conditions for the Klamath River from the Hydroelectric Reach through the Klamath River Estuary and the Pacific Ocean nearshore environment are detailed for the Area of Analysis. Phytoplankton, including blue-green algae, grow best in slow-moving, stable water conditions, so they compose the majority of the algal community in the reservoirs and occasionally occur in slow-moving water portions (e.g., backwater eddies and near shore shallows) of the mainstem Klamath River. Blue-green algae growth varies seasonally in the Hydroelectric Reach, reaching nuisance levels in the Copco No. 1 and Iron Gate reservoirs primarily during summer and fall months. In the Klamath River downstream of the Hydroelectric Reach, blue-green algae are less abundant due to limited slow-moving water habitat, but nuisance levels of blue-green algae occasionally occur when blue-green algae cells from the reservoirs drift downstream and habitat conditions in the mainstem river favor blue-green algae growth. Periphyton, including diatoms, green algae, fungi, and bacteria, primarily grow attached to the streambed and/or other underwater surfaces, so they grow best in the river reaches of the Klamath River. While periphyton are not abundant in the Hydroelectric Reach due to limited suitable habitat, periphyton dominate the algal community in the Middle and Lower Klamath River. Spatial and seasonal variations in periphyton correspond to changes in nutrients concentrations and flow conditions. Section 3.4.2 *[Phytoplankton and Periphyton Resources] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, phytoplankton and periphyton resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of phytoplankton and periphyton resource area effects (Section 3.4 *Phytoplankton and Periphyton*). The non-project activity types evaluated for cumulative impacts on phytoplankton and periphyton shown below are those that would potentially alter the water temperature, hydrodynamic (water movement), and nutrient availability conditions in the Klamath River within the Area of Analysis. Changes in these variables due to the cumulative impact of the Proposed Project and other closely related projects could potentially increase the extent of optimal habitat for phytoplankton or periphyton in the Area of Analysis, contributing to additional impairment of designated beneficial uses. While wildfire is a natural occurrence, under climate change more frequent and intense wildfires are reasonably foreseeable (Bedsworth et al. 2018) and thus wildfires are also evaluated for potential cumulative impacts on phytoplankton and periphyton. The non-project activity types (plus wildfires) are included in Table 3.24-1.

Significance criteria for cumulative phytoplankton and periphyton impacts are the same as those defined in Section 3.4.3 *[Phytoplankton and Periphyton] Significance Criteria.*

Potential Cumulative Impact 3.24-16 Long-term phytoplankton and periphyton effects from the Proposed Project in combination with habitat restoration, flow enhancement, and water quality improvement projects.

Habitat restoration, flow enhancement, and water quality improvement projects along the Klamath River and its tributary creeks and rivers would alter phytoplankton and periphyton growth and habitat conditions by modifying the hydrodynamic and nutrient availability conditions in the Area of Analysis. Stream channel improvements, riparian habitat restoration, placement of off-channel habitat features, floodplain restoration, incorporation of large wood into tributaries to the Klamath River, and increases in stream flow in the Klamath River would all influence local phytoplankton and periphyton conditions where the restoration occurs, but these activities may have limited influence on phytoplankton and periphyton within the Area of Analysis if they occur outside of the Area of Analysis.

Habitat restoration, flow enhancement, and water quality improvement projects likely would have a beneficial effect on local phytoplankton and periphyton conditions by increasing turbulent mixing and reducing nutrient concentrations, but the creation of off-channel features may produce low mixing conditions and slow water habitat under some flow conditions, potentially leading to localized phytoplankton growth in backwater areas.

The Proposed Project conversion of reservoir areas to free-flowing river reaches would have a beneficial effect on phytoplankton conditions in the Klamath River from the Hydroelectric Reach to the Klamath River Estuary because it would eliminate slow-moving habitat that promotes nuisance and/or noxious blue-green algae blooms that are transported throughout these reaches of the Klamath River (Potential Impact 3.4-1). However, the conversion of reservoir areas to free-flowing river reaches would result in a significant and unavoidable impact on periphyton conditions because the newly created free-flowing river reaches would provide additional low-gradient habitat suitable for periphyton growth. The extent, duration, or biomass of nuisance periphyton may increase within these newly created free-flowing river reaches. Short-term and long-term nutrient increases from the release of sediment-associated nutrients or the lack of interception of nutrients behind the Lower Klamath Project dams due to the Proposed Project would be less than significant for phytoplankton and periphyton growth and habitat conditions, so they would have no significant impact on phytoplankton or periphyton (and Potential Impacts 3.4-1, 3.4-3, and 3.4-5).

As the Proposed Project would not have a significant adverse impact on phytoplankton related to restoration and flow enhancements and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no cumulative phytoplankton impacts due to the Proposed Project and habitat restoration, flow enhancement, and water quality improvement projects.

Although the Proposed Project would result in significant and unavoidable adverse impacts due to periphyton increases in the newly created free-flowing river reaches (see Potential Impact 3.4-4), there are no closely related anticipated activities associated with habitat restoration, flow enhancement, and water quality improvement projects that would, in combination with the Proposed Project, result in further significant and adverse periphyton impacts. Thus, there would be no cumulative periphyton impacts due to the Proposed Project and habitat restoration, flow enhancement, and water quality improvement projects.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-17 Short-term and long-term phytoplankton and periphyton effects from the Proposed Project in combination with 2017 court-ordered flushing and emergency dilution flows.

Formal consultation was reinitiated in 2017 on the NMFS and USFWS 2013 Joint Biological Opinion. Until formal consultation is completed and a new biological opinion (BiOp) issued, USBR is required to continue adhering to the 2013 BiOp Flow requirements while also releasing additional winter-spring surface and deep flushing flows and potentially emergency dilution flows (U.S. District Court 2017). New BiOp Flows would alter the hydrodynamic (i.e., flow) conditions in the Klamath River within the phytoplankton and periphyton Area of Analysis. The potential new BiOp flow requirements under the Proposed Project are speculative since the fish disease conditions that prompted the flushing and emergency dilution flow requirements would be reduced due to increased dispersal of spawners and carcasses, transport of bedload, and establishment of variable flows, even if infection itself is not eliminated (see Section 3.3.5.5 *Fish Disease and Parasites*). Further, if flushing and emergency dilution flow requirements were to continue under a new BiOp, it is not clear if the prior location of Iron Gate Dam would remain as the compliance point. Thus, this cumulative effects analysis analyzes only the 2017 flow requirements (i.e., 2013 BiOp Flows plus the 2017 court-ordered flushing and emergency dilution flows), which although not part of the existing conditions (2016), are considered to be a reasonably foreseeable flow condition until formal consultation is completed and a new BiOp is issued (see Potential Cumulative Impact 3.24-2 for more details).

The Proposed Project and 2017 flow requirements would decrease favorable growth conditions and optimum habitat availability for phytoplankton or periphyton since they are designed to limit periphyton establishment along the streambed, which also limits favorable habitat for the polychaete worm that hosts fish parasites (e.g., *C. shasta*) (see Section 3.3.5.5 *Fish Disease and Parasites*). Additionally, an increase in the frequency of higher flushing flows and emergency dilution flows between November and June would increase turbulent flows in the Klamath River, reducing the extent of slow-water habitat that favors phytoplankton growth. The Proposed Project would eliminate slow-water habitat in the reservoir areas and convert those areas into more turbulent free-flowing reaches that would not support extensive phytoplankton blooms, including blue-green algae blooms (Potential Impact 3.4-2). As such, the cumulative effect of the Proposed Project combined with an increase the frequency of flushing flows and emergency dilution flows would result in a beneficial effect by further reducing the availability of slow-water habitat that supports nuisance and/or noxious phytoplankton blooms.

The increase in the frequency of higher flushing flows and emergency dilution flows between November and June under the 2017 flow requirements would also increase sediment movement and streambed scour in the Klamath River, reducing conditions where periphyton could establish along the streambed when flushing flows or emergency dilution flows are occurring. As discussed in Section 3.4.5.2 *Periphyton*, the Proposed Project drawdown flows would mobilize streambed sediments and scour periphyton attached to the streambed, especially at higher flows that move larger sediments like cobbles (Potential Impact 3.4-3). Although the Proposed Project would result in an increase in periphyton and a potentially significant and unavoidable short-term and long-term increase in nuisance periphyton along the Hydroelectric Reach due to the conversion of the reservoir areas to a free-flowing river and elimination of hydropower peaking operations, the cumulative effect of increase in the frequency of higher flushing flows and emergency dilution flows would be beneficial and reduce the extent, duration, and biomass of nuisance periphyton.

Overall, the combined effect from the Proposed Project and the 2017 flow requirements would reduce the spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton blooms and the spatial extent, temporal duration, or biomass of nuisance periphyton. The combined effect from the Proposed Project and the 2017 flow requirements would potentially have a short-term and long-term beneficial effect in the Hydroelectric Reach and the Middle Klamath River by increasing streambed scour and reducing or eliminating the growth and establishment of nuisance periphyton growth during higher November through June flow conditions.

As the Proposed Project would not have a significant adverse impact on phytoplankton (Potential Impacts 3.4-1 and 3.4-2) and the flushing flows and emergency dilution flows in the 2017 flow requirements would increase turbulent flows in the Klamath River and reduce the extent of slow-water habitat that favors phytoplankton growth, there would be beneficial cumulative effects on phytoplankton due to the combined effects of the Proposed Project and the 2017 flow requirements.

Although the Proposed Project would result in significant and unavoidable adverse impacts due to periphyton increases, there are no closely related anticipated activities associated with the 2017 flow requirements that would, in combination with the Proposed Project, result in further significant and adverse periphyton impacts. Thus, there would be no significant cumulative periphyton impacts due to the Proposed Project associated with the 2017 flow requirements.

Significance

Beneficial cumulative effects for phytoplankton

No significant cumulative impact for periphyton

Potential Cumulative Impact 3.24-18 Short-term and long-term phytoplankton and periphyton effects from the Proposed Project in combination with forest and wildfire management projects.

In the phytoplankton and periphyton Area of Analysis, anticipated forest and wildfire management projects would involve thinning in stands for forest health and fuel reduction, using prescribed fire, creating strategic fuel breaks, implementing fuel treatments including under-burning and pile burning, revegetating areas to accelerate the development of mature forest, enhancing meadow conditions, improving water temperature and sediment conditions in streams, modifying road conditions, and increasing recreational opportunities. Vegetation removal or enhancement near streams would potentially affect phytoplankton and periphyton, since the activities would potentially alter the solar radiation and water temperature in the streams. Additional solar radiation from vegetation removal would potentially enable more phytoplankton or periphyton photosynthesis and growth. Higher water temperatures may potentially increase phytoplankton or periphyton growth and/or production of blue-green algae toxins, if the duration that water temperatures are within growth or toxin production optimum temperatures increases. Forest and wildfire management projects may also alter suspended sediment conditions in streams due to vegetation modifications (e.g., removal or enhancement), prescribed burns, fuel treatments, and road construction and usage increasing erosion. Reductions in suspended sediment would increase light availability in the stream, especially at the streambed, potentially increasing phytoplankton or periphyton photosynthesis and growth. While phytoplankton and periphyton are not directly addressed by the North Coast Regional Water Quality Control Board's Forest Activities Program, the program issues waste discharge requirements and general waivers with terms and conditions to address the potential water quality problems (e.g., water temperature or suspended sediment increases) potentially associated with a range of forest management activities on private and on USDA Forest Service lands (North Coast Regional Board 2018c).

Reasonably foreseeable forest and wildfire management projects within or near the water quality Area of Analysis are included in Table 3.24-1. The Proposed Project and forest and wildfire management activities would result in no significant cumulative impact on phytoplankton and periphyton because the cumulative magnitude of changes to solar radiation, water temperature, or suspended sediment would not be anticipated to alter phytoplankton and periphyton growth conditions in the Area of Analysis. Most anticipated forest and wildfire management activities are not located near the Area of Analysis, so potential overlap between the effects of the Proposed Project and forest and wildfire management activities is limited. Potential changes to solar radiation, water temperature, and/or suspended sediment from forest and wildfire management activities may alter local habitat and growth conditions for phytoplankton and periphyton, but they would be unlikely to alter habitat and growth conditions within the Area of Analysis. Additionally, Proposed Project impacts associated with drawdown (e.g., Potential Impact 3.4-1 and 3.4-3) would primarily occur during November through March when forest and wildfire management activities (e.g., prescribed burns or commercial logging) are less likely to occur. Forest and wildfire management activities would also have opposing effects on phytoplankton and periphyton growth, further limiting the cumulative effect of those near the Area of Analysis. Vegetation removal and temporary or permanent road construction and usage for tree removal (i.e., logging) would potentially increase phytoplankton and periphyton growth in the local vicinity of the project due to increases in solar radiation and water temperature or reductions in suspended sediment, but revegetating areas, enhancing riparian cover along meadow streams, and decommissioning or downgrading roads to reduce suspended sediment delivery to streams activities would potentially decrease phytoplankton and periphyton growth by reducing solar radiation and water temperature or increasing suspended sediment.

As the Proposed Project would not have a significant adverse impact on phytoplankton and periphyton related to forest and wildfire management and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no significant cumulative phytoplankton or periphyton impacts in the short term or long-term due to the Proposed Project associated with forest and wildfire management.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-19 Short-term and long-term phytoplankton and periphyton effects of the Proposed Project in combination with potential wildfire. Wildfires regularly occur within the Klamath Basin, with multiple large fires occurring in 2016 through 2018 (see also Table 3.24-1), and fires likely to occur in future years. Wildfires could potentially increase phytoplankton and periphyton growth by reducing the vegetation cover around streams, resulting in more solar radiation reaching the stream and warmer water temperatures. Phytoplankton and periphyton growth may also decrease due to wildfires as increases in suspended sediment from increased erosion in burn areas reduce light availability for growth. While there are potential phytoplankton and periphyton growth and habitat effects from wildfires, the magnitude of fires and their proximity to the phytoplankton and periphyton Area of Analysis would likely determine the cumulative impact of wildfires.

The Proposed Project would not have a significant short-term or long-term impact on phytoplankton (Potential Impacts 3.4-1 and 3.4-2), but it would have a long-term beneficial effect by reducing available habitat suitable for blue-green algae growth in the Hydroelectric Reach and transport of blue-green algae downstream of the Hydroelectric Reach. Wildfires may locally effect phytoplankton habitat in the phytoplankton and periphyton Area of Analysis if they occur immediately adjacent or upslope from the Klamath River, but these local effects would be unlikely to significantly alter the availability or suitability of phytoplankton habitat in the Klamath River. While a late-season (e.g., November) wildfire that burns near or within the phytoplankton and periphyton Area of Analysis followed by heavy rain would result in a potential short-term cumulative increase in the SSCs (see Potential Cumulative Impact 3.24-4), this would occur during late-fall/winter conditions when phytoplankton growth is already naturally low due to less light availability and colder temperatures and there would be minimal change in phytoplankton growth due less vegetation along the river edge or an increase in SSC and turbidity. Thus, the overall effects of wildfire on phytoplankton habitat and growth would be limited and wildfires would be unlikely to produce an increase in the extent, duration, toxicity, or concentration of nuisance and/or noxious phytoplankton blooms, including blue-green algae, in the Area of Analysis that would combine with the Proposed Project effects to result in a significant and adverse impact on phytoplankton.

There were no significant short-term or long-term impacts in the Klamath River from the Proposed Project due to changes in nutrients (Potential Impact 3.4-3 and Potential Impact 3.4-5), since the increase in nutrients either occurred during periods when periphyton growth rates were low or nutrient increases were offset by other competing processes that would limit overall periphyton growth. However, the Proposed Project would result in significant and unavoidable adverse impacts for periphyton due to increases in available low-gradient channel margin habitat in the Hydroelectric Reach from conversion of the reservoir areas to free-flowing river (Potential Impact 3.4-4). Wildfires would not significantly alter nutrient conditions in the Klamath River or the availability of periphyton habitat in the Klamath River. As such, the combined effect of the Proposed Project and wildfires would be unlikely to produce an increase in the spatial extent, temporal duration, or biomass of nuisance periphyton in the Area of Analysis that would result in a significant and adverse impact.

As the Proposed Project would not have a significant adverse impact on phytoplankton and periphyton related to wildfire and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no significant cumulative phytoplankton or periphyton impacts in the short term or long-term due to the Proposed Project associated with wildfires.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-20 Short-term and long-term phytoplankton and periphyton effects from the Proposed Project in combination with potential cannabis cultivation.

There are numerous anticipated cannabis cultivation projects within the Klamath Basin that could potentially affect phytoplankton and periphyton growth in the Klamath River. Flow diversions for cultivation reduce stream flows, result in more rapid warming and higher water temperatures, and increase light availability at the streambed for periphyton growth. Erosion of cultivated land potentially increases suspended sediment, reducing light availability in streams. Stormwater runoff containing fertilizer potentially increases nutrient loading in streams, promoting additional phytoplankton or periphyton growth.

While there are potential phytoplankton and periphyton impacts from cannabis cultivation, many cannabis cultivation projects are part of existing conditions and numerous regulatory agencies manage the water diversions and water quality effects of runoff from cannabis cultivation. New or existing permitted cannabis cultivation projects would be required to adhere to these regulations and implement project-specific measures to minimize or reduce to less than significant potential water quality impacts that could alter phytoplankton and periphyton conditions in streams. Additionally, most of the cannabis cultivation projects listed in Table 3.24-1 include a specified location identified in permitting documents and are not located near the phytoplankton and periphyton Area of Analysis, so potential impacts from cannabis cultivation would be unlikely to significantly overlap with the Proposed Project impacts. Short-term and long-term nutrient increases from the release of sediment-associated nutrients or the lack of interception of nutrients behind the Lower Klamath Project dams due to the Proposed Project are expected to have no significant impact on phytoplankton or periphyton (Potential Impact 3.4-3 and Potential Impacts 3.4-1 and 3.4-5). As the Proposed Project would not have a significant adverse impact on phytoplankton and periphyton related to cannabis cultivation and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no significant cumulative phytoplankton or periphyton impacts in the short term or long-term due to the Proposed Project associated with cannabis cultivation.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-21 Short-term and long-term phytoplankton and periphyton effects from the Proposed Project in combination with grazing and agricultural projects.

Phytoplankton and periphyton growth and habitat conditions in the Klamath River could potentially be altered by grazing and agricultural projects because they would potentially increase the solar radiation and water temperature in the streams due to reductions in riparian vegetation (grazing); decrease light availability within streams due to increased suspended sediment from soil disturbance and increased erosion (grazing and agriculture); and increase nutrients in streams due to stormwater runoff from areas containing livestock waste (grazing) or fertilizers (agriculture). However, most of the anticipated grazing and agricultural projects would not have the potential to impact phytoplankton and periphyton conditions because they would not be within the phytoplankton and periphyton Area of Analysis or the vicinity of the mainstem Klamath River (Table 3.24-1). Reasonably foreseeable grazing and agricultural projects near the phytoplankton and periphyton Area of Analysis include Dry Lake and Horse Creek Grazing Allotment, Lake Mountain & Middle Tompkins Grazing Allotment, and Cannaworx Zone Change (see also Table 3.24-1).

Additionally, future public land grazing allotment environmental assessments and approvals along with any reviews and approvals required for agricultural projects would reasonably incorporate project-specific measures to reduce potential water quality impacts, including storm water management, streambank setbacks, or exclusionary livestock fencing. Grazing and agricultural projects are required to meet the requirements of the North Coast Regional Water Quality Control Board’s Agricultural Lands Discharge Program, including a series of waivers of waste discharge requirements when applicants comply with best management practices designed to meet state water quality requirements, the State Nonpoint Source Policy, and the TMDLs in specific watersheds (North Coast Regional Board 2018a). These project-specific measures would reduce the potential effects to phytoplankton and periphyton growth and habitat conditions because the primary effects of grazing and agriculture on phytoplankton and periphyton growth are due to changes in the water quality (e.g., water temperature, suspended sediment, or nutrients). Grazing and agricultural projects implementing such project-specific measures would reduce their impact on phytoplankton and periphyton growth. As discussed under Potential Impact 3.4-1, 3.4-3, and 3.4-5, the short-term and long-term nutrient increases from the release of sediment-associated nutrients or the lack of interception of nutrients behind the Lower Klamath Project dams due to the Proposed Project are less than significant for phytoplankton and periphyton growth and habitat conditions, so they would have no significant impact on phytoplankton or periphyton. As the Proposed Project would not have a significant adverse impact on phytoplankton and periphyton related to grazing and agricultural projects and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no significant cumulative phytoplankton or periphyton impacts in the short term or long-term due to the Proposed Project and grazing and agricultural projects.

Significance
No significant cumulative impact

Potential Cumulative Impact 3.24-22 Short-term and long-term phytoplankton and periphyton effects from the Proposed Project in combination with mining.
Most of the anticipated mining projects are not within the phytoplankton and periphyton Area of Analysis or the vicinity of the mainstem Klamath River (Table 3.24-1), so they would not impact phytoplankton and periphyton conditions within the Area of Analysis. Projects in the vicinity of the phytoplankton and periphyton Area of Analysis include the Brooks Mine, an existing mine located approximately five miles south of the Klamath River, near Humbug Creek, California. Any existing mining operations impacts on the phytoplankton and periphyton Area of Analysis are accounted for in the analysis of the existing conditions. Mining could potentially alter light availability for phytoplankton and periphyton in the Klamath River by increasing suspended sediment conditions, but since mining projects would be required to adhere to local, state, and/or federal mining regulations to protect water quality and implement project-specific measures to manage and reduce potential water quality impacts, there would be no cumulative impact. Stormwater management, waste discharge permits, and monitoring would all likely be necessary for any mining projects adjacent or draining to waterways. Mining projects implementing such project-specific measures would reduce their impacts on phytoplankton and periphyton growth. There are no significant adverse phytoplankton or periphyton impacts due to suspended sediment concentrations under the Proposed Project (Potential Impact 3.4-4 and Potential Impacts 3.4-1, 3.4-2, 3.4-3, and 3.4-5). As the Proposed Project would not have a significant adverse impact on phytoplankton and periphyton related to mining cultivation and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no significant cumulative phytoplankton or periphyton impacts in the short term or long-term due to the Proposed Project and mining projects.

Significance
No significant cumulative impact

3.24.5 Terrestrial Resources

The Primary Area of Analysis for terrestrial resources includes the area within the Limits of Work, a 0.25- to 1.0-mile buffer surrounding the Limits of Work, and a 0.25-mile buffer of the Klamath River from the California border to the Pacific Ocean (Figure 3.5-1).

Existing conditions for terrestrial resources are described in Section 3.5.2 *[Terrestrial Resources] Environmental Setting*. The Primary Area of Analysis for terrestrial resources includes diverse habitats, ranging from wetland surfaces just below sea level in the Klamath River Estuary (-0.16 feet elevation) to the slopes above the Upper Klamath River near the California-Oregon state line (3,428 feet elevation), and includes 19 different CWHR vegetation types. These vegetation types have the potential to support numerous special-status plant and wildlife species; species with the potential to occur in the Primary Area of Analysis for terrestrial resources are provided in Tables 3.5-4 and 3.5-5 and information about documented occurrences of special-status species within the Primary Area of Analysis for terrestrial resources are provided in Section 3.5.2 *[Terrestrial Resources] Environmental Setting*. Section 3.5.2 *[Terrestrial Resources] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, terrestrial resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of terrestrial resource area effects (Section 3.5). Non-project activity types within the Primary Area of Analysis for terrestrial resources with the potential for significant cumulative impacts to terrestrial resources are those that may result in noise, ground disturbance, habitat alteration, and/or changes to water flows and water quality, and are included in Table 3.24-1.

Significance criteria for cumulative terrestrial resources impacts are the same as defined in Section 3.5.3 *[Terrestrial Resources] Significance Criteria*.

Potential Cumulative Impact 3.24-23 Long-term effects on terrestrial resources from the Proposed Project in combination with restoration, flow enhancement, and water quality improvement projects.

The Proposed Project includes restoration elements, as defined in the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*), that would be beneficial to willow flycatcher (Potential Impact 3.5-12), rare natural communities, wetlands, and riparian vegetation (Potential Impact 3.5-24), as well as wildlife movement corridors (Potential Impact 3.5-29). The other reasonably foreseeable restoration, flow enhancement, and water quality improvement projects within or near the Primary Area of Analysis for terrestrial resources (Table 3.24-1) would also enhance terrestrial resources in the long term by restoring native vegetation and creating beneficial wildlife habitat (e.g., western pond turtle basking habitat, foothill yellow-legged frog breeding habitat) through activities such as the placement of off-channel habitat features, floodplain restoration, and incorporation of large wood into tributaries to the Klamath River. The Proposed Project, in combination with reasonably foreseeable restoration, flow enhancement, and water quality improvement projects, would result in beneficial cumulative effects on terrestrial resources.

Significance

Beneficial cumulative effects

Potential Cumulative Impact 3.24-24 Short-term effects on terrestrial resources from the Proposed Project in combination with 2017 court-ordered flushing and emergency dilution flows.

The 2013 BiOp Flows have been analyzed under the individual resource sections for the Proposed Project. Potential Impact 3.24-1 in Section 3.24.2 *Cumulative Water Quality*

Effects provides background and context regarding agency re-consultation on the 2013 Joint Biological Opinion. For the reasons set out in Potential Impact 3.24-1, this analysis only considers the 2017 court-ordered flow requirements, which are not part of the existing conditions, and are a reasonably foreseeable flow condition; this analysis does not consider the potential new BiOp. The court-ordered flushing and emergency dilution flows are required primarily to reduce *C. Shasta* infection of Klamath River salmonids. Potential Impact 3.24-1 determines that it is unlikely that there would be exceedances of disease thresholds that would trigger emergency dilution flows In the short term, particularly in dam removal year 2; therefore, emergency dilution flows are not expected to temporally overlap with the Proposed Project. 2017 court-ordered flushing flows may overlap in space and time with the Proposed Project, thus are the focus of this analysis.

Sediment discharge, sedimentation, and impacts to channel morphology from the Proposed Project are not expected to substantially adversely impact in-channel and riparian vegetation downstream of Iron Gate Dam (Potential Impact 3.5-4). This is because vegetation growing within, or along, the river channel margins can likely withstand, or revegetate following, this scale of perturbation, which is not dissimilar to seasonal and inter-annual river system dynamics over the past century. Conversely, sediment discharge, sedimentation, and changes to channel morphology would result in potentially significant impacts to the foothill yellow-legged frog (Potential Impact 3.5-16).

In years where reservoir drawdown flows would not meet the magnitude or duration of flushing flow requirements, surface and/or deep flushing flows may be implemented to meet the 2017 court-ordered flow requirements, which would be additional to flows from the Proposed Project. Although the magnitude of flows would not be greater than assessed in Section 3.5.5 *[Terrestrial Resources] Impacts and Mitigation*, there are one to two months when flushing flows may occur outside of the Proposed Project reservoir drawdown period (November 1 to March 15) since surface flushing flows potentially would occur until April 30 and deep flushing flows potentially would occur until May 31. Given that the surface and/or deep flushing flows are within the range of flows modeled for the Proposed Project, it is unlikely that sediment discharge, sedimentation, and impacts to channel morphology, would exceed what in-channel riparian vegetation can withstand, or that vegetation would not revegetate in a few years, due to the combination of flushing flows and reservoir drawdown.

With regard to wildlife, the combination of the Proposed Project and the 2017 court-ordered surface and/or deep flushing flows would extend the period of high flows that could scour foothill yellow-legged frog eggs or displace tadpoles (Potential Impact 3.5-16); however since flows would be expected to remain below the 10-year flood event, the incremental impact of the Proposed Project to potential scour of foothill yellow-legged frog eggs would not be cumulatively considerable.

Significance

No significant cumulative impact on riparian vegetation or wildlife

Potential Cumulative Impact 3.24-25 Short-term effects on terrestrial resources from forest and wildfire management.

The Proposed Project includes ground-disturbing activities (i.e., construction) that would have significant short-term impacts on wetlands and riparian habitats before mitigation (Potential Impact 3.5-1). Additionally, the Proposed Project includes ground-disturbing activities (i.e., construction and dam removal) that would have significant and unavoidable impacts on special-status plant species and rare natural communities (Potential Impacts 3.5-7 and 2.5-8). The Proposed Project would also result in noise and habitat modifications that would have significant short-term impacts on terrestrial wildlife species before mitigation (Potential Impact 3.5-10 for amphibians and reptiles), and a significant and unavoidable impacts on some other terrestrial wildlife species (Potential Impacts 3.5-10 for other special-status wildlife species, 3.5-11, 3.5-12, 3.5-13, and 3.5-14). Other forest and wildfire management activities within the Primary Area of Analysis for terrestrial resources (Table 3.24-1) could result in improved forest health and open understory for wildlife to traverse and create habitat for wildlife that use mature forests; however, there are potential impacts on terrestrial resources from forest and wildfire management activities. For example, if a forest and wildfire management project occurred during the breeding season, adults may abandon young and/or young may be trapped and unable to escape. Most known forest and wildfire management projects are not close to the mainstem Klamath River, except the Somes Bar Integrated Fire Management Project (approximately 90 miles downstream of Humbug), and Crawford Vegetation Management Project (approximately 70 miles downstream of Humbug). Although details of implementation methods for other planned forest and wildfire management activities are currently speculative, these projects would be required to adhere to state and/or federal guidelines (e.g., CEQA, California Endangered Species Act [CESA], and California Forest Practice Rules) which ensure that sensitive habitats (e.g., wetlands), rare natural communities, and special-status plant and wildlife species are inventoried prior to project implementation and avoided, or that mitigation is applied where necessary. Given that the other known forest and wildfire management projects are expected to adhere to state and/or federal guidelines, there would be no significant cumulative ground-disturbing, noise, or habitat modification impacts from the Proposed Project in combination with forest and wildfire management projects.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-26 Short-term effects on terrestrial resources from the Proposed Project in combination with wildfire.

The Proposed Project includes ground-disturbing activities (i.e., construction) that would have significant short-term impacts on wetlands and riparian habitats before mitigation (Potential Impact 3.5-1). Additionally, the Proposed Project includes ground-disturbing activities (i.e., construction and dam removal) that would have significant and unavoidable impacts on special-status plant species and rare natural communities (Potential Impacts 3.5-7 and 2.5-8). The Proposed Project would result in noise and habitat modifications that would have significant short-term impacts on terrestrial wildlife species before mitigation (Potential Impact 3.5-10 for amphibians and reptiles). Additionally, the Proposed Project would result in noise and habitat modifications that would have significant and unavoidable impacts on terrestrial wildlife species (Potential Impact 3.5-10 for other special-status wildlife species, 3.5-11, 3.5-12, 3.5-13, and 3.5-14).

Wildfires regularly occur within the Klamath Basin, with multiple fires occurring in 2016 through 2018 (Table 3.24-1). Due to climate change, forests will be more susceptible to extreme wildfires, with an almost 50 percent increase in the frequency of extreme wildfires that burn over approximately 25,000 acres, and a 77 percent increase in the average area burned statewide by the end of the century (Bedsworth et al. 2018). Large fires can burn hundreds to thousands of acres; for example, in 2016 844 acres were burned in Siskiyou County. Although wildfires are a natural occurrence in California and low burning fires can improve forest health, potential impacts on special-status wildlife and plant species may occur. For example, if a wildfire occurred during the breeding season, adults may abandon young and/or young may be trapped and unable to escape. If a large fire occurs in the Primary Area of Analysis for terrestrial resources during the construction period for the Proposed Project, work would be suspended due to health and safety reasons (see Potential Cumulative Impact 3.24-34 [*Air Quality]*); therefore, temporal overlap is unlikely. If a large fire occurs in the Primary Area of Analysis for terrestrial resources immediately before or after the construction period for the Proposed Project, there could be a significant cumulative impact to terrestrial resources from the combination of the Proposed Project and wildfire, as the area affected would be increased, and the duration of time wildlife and vegetation are affected would be extended. However, the area of terrestrial resources affected by wildfire would likely be substantially greater than the confined construction, staging, and access areas affected by the Proposed Project; therefore, the incremental effect of the Proposed Project to terrestrial resources would not be cumulatively considerable in the context of wildfire.

<u>Significance</u>

Not cumulatively considerable

Potential Cumulative Impact 3.24-27 Short-term and long-term effects on terrestrial resources from the Proposed Project in combination with agriculture, including cannabis cultivation.

The Proposed Project includes ground-disturbing activities (i.e., construction) that would have significant short-term impacts on wetlands and riparian habitats before mitigation (Potential Impact 3.5-1), and ground-disturbing activities (i.e., construction and dam removal) that would have significant and unavoidable impacts on special-status plant species and rare natural communities (Potential Impacts 3.5-7 and 2.5-8). Additionally, the Proposed Project would result in noise and habitat modifications that would have significant short-term impacts on terrestrial wildlife species before mitigation (Potential Impact 3.5-10 for amphibians and reptiles), and significant and unavoidable impacts on some other terrestrial wildlife species (Potential Impact 3.5-10 for other special-status wildlife species, 3.5-11, 3.5-12, 3.5-13, and 3.5-14). Most agricultural projects, including cannabis cultivation projects, are reauthorizations of existing activities (Table 3.24-1) thus are captured by existing conditions, or are situated far from the Hydroelectric Reach where primary disturbances will take place for the Proposed Project; except for the adopted Cannaworx Zone Change near Humbug. Modifications to policies for agricultural zones to support pastured hog and poultry operations, as well as agritourism, are also underway in Siskiyou County (Table 3.24-1). Although details of implementation methods for other grazing projects are currently speculative, grazing management plans are required to adhere to state and/or federal guidelines which ensure that sensitive habitats (e.g., wetlands), rare natural communities, and special-status plant species are inventoried prior to project implementation and avoided, or that mitigation is applied where necessary. Additionally, there is a suite of relevant legislation for cannabis cultivation projects (see Potential Cumulative Impact 3.24-5 for details). Given that any closely related agricultural projects that do fall within the Primary Area of Analysis are expected to adhere to state and/or federal guidelines, any adverse ground-disturbing impact to terrestrial resources is unlikely to be cumulatively significant.

Implementation of the Proposed Project would provide long-term benefits to wildlife by increasing connectivity within the Primary Area of Analysis for terrestrial resources (Potential Impact 3.5-29). Specifically, the Proposed Project enables wildlife movement by removing the Lower Klamath Project reservoirs and dam structures, incorporating wildlife-friendly fencing, allowing for the movement of wildlife such as deer and elk, which would be placed around the reservoirs to increase the success of restoring the reservoir areas (Section 2.7.4 *Restoration Within the Reservoir Footprint*), and incorporating the use of grazing animals (sheep, goats) to control invasive species (2.7.5 *Restoration of Upland Areas Outside of the Reservoir Footprint*). Grazing projects (Table 3.24-1) within or near the Primary Area of Analysis for terrestrial resources may result in reduced habitat connectivity with the installation of any new fences, ground disturbance, and reduced water quantity and quality affecting special-status terrestrial species, such as amphibians and reptiles. Although some other grazing projects could reduce wildlife connectivity through fencing installation, because the Proposed Project would increase connectivity, there would be no cumulative wildlife connectivity impacts on terrestrial resources due to implementation of the Proposed Project and grazing projects.

Cannabis cultivation projects and grazing and agricultural projects (Table 3.24-1) within or near the Primary Area of Analysis for terrestrial resources may result in reduced water quality affecting special-status terrestrial species such as amphibians and reptiles. Please see Potential Cumulative Impacts 3.24-25 and 3.24-26 for a discussion of the potential cumulative water quality impacts of the Proposed Project in combination with cannabis cultivation projects and grazing and agricultural projects. Given that Potential Cumulative Impacts 3.24-25 and 3.24-26 determine *no significant cumulative impact*, a follow-on cumulative impact to terrestrial species from adverse water quality is not foreseeable, and there would be no significant cumulative impact to terrestrial resources from cumulatively adverse water quality conditions.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-28 Short-term effects on terrestrial resources from the combination of the Proposed Project and mining.

The Proposed Project includes ground-disturbing activities (i.e., construction) that would have significant short-term impacts on wetlands and riparian habitats before mitigation (Potential Impact 3.5-1), and ground-disturbing activities (i.e., construction and dam removal) that would have significant and unavoidable impacts on special-status plant species and rare natural communities (Potential Impacts 3.5-7 and 2.5-8). The Proposed Project would also result in noise and habitat modifications that would have significant short-term impacts on terrestrial wildlife species before mitigation (Potential Impact 3.5-10 for amphibians and reptiles), and a significant and unavoidable impacts on terrestrial wildlife species (Potential Impact 3.5-10 for other special-status wildlife species, 3.5-11, 3.5-12, 3.5-13, and 3.5-14). Mining projects within the Primary Area of Analysis for terrestrial resources (Table 3.24-1) could also result in ground disturbance. Most other mining projects are withdrawal or remediation projects, renewals of existing permits in Del Norte County, or are situated in the Salmon River sub-basin (far from the

Hydroelectric Reach), with the exception of the new Plan of Operations for the existing Brooks Mine (Table 3.24-1). The new plan of operations for the Brooks Mine is near the expected hydrological and sedimentation footprint from dam removal, which extends downstream to Humbug Creek. Although details of implementation methods for mining projects are currently speculative, these projects would be required to adhere to state and/or federal guidelines, which would ensure that sensitive habitats (e.g., wetlands), rare natural communities, and special-status plant species are inventoried prior to project implementation and avoided, or that mitigation is applied where necessary. Given that the only expected mining project within the Primary Area of Analysis for terrestrial resources is a new plan of operations there would be no significant ground-disturbing impact to terrestrial resources from the combination of the Proposed Project and other closely related mining projects.

Mining projects (Table 3.24-1) within or near the Primary Area of Analysis for terrestrial resources may result in reduced water quality affecting special-status terrestrial species such as amphibians and reptiles. The majority of mining projects are located outside of the terrestrial Primary Area of Analysis. A new (20-acre) Plan of Operations for the existing Brooks Mine (Table 3.24-1) is near the expected hydrological and sedimentation footprint from dam removal, which extends downstream to Humbug Creek. Impacts from mining projects on water quality, and terrestrial wildlife that use waterways, would be anticipated to be less than significant, since mining projects would be required to adhere to existing water quality regulations and implement project-specific measures (e.g., storm water management). Although the Proposed Project would result in significant and unavoidable adverse impacts due to short-term water quality impacts (as described in Cannabis Cultivation above), there are no closely related grazing projects that would, in combination with the Proposed Project, result in further significant and adverse impacts to water quality that would cumulatively affect terrestrial wildlife. Thus, there would be no cumulative water quality impacts on terrestrial wildlife due to the Proposed Project in combination with closely related mining projects.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-29 Short-term effects on terrestrial resources from the Proposed Project in combination with development and infrastructure projects.

The Proposed Project includes ground-disturbing activities (i.e., construction) that would have: significant short-term impacts on wetlands and riparian habitats before mitigation (Potential Impact 3.5-1). Additionally, the Proposed Project includes ground-disturbing activities (i.e., construction and dam removal) that would have significant and unavoidable impacts on special-status plant species and rare natural communities (Potential Impacts 3.5-7 and 2.5-8). The Proposed Project would also result in noise and habitat modifications that would have significant short-term impacts on terrestrial wildlife species before mitigation (Potential Impact 3.5-10 for amphibians and reptiles), and a significant and unavoidable impacts on terrestrial wildlife species (Potential Impact 3.5-10 for other special-status wildlife species, 3.5-11, 3.5-12, 3.5-13, and 3.5-14). Development activities (Table 3.24-1) could have overlapping adverse impacts; however, no large-scale development projects are proposed within the Primary Area of Analysis for terrestrial resources. Development projects such as the potential nanocellulose facility in Yreka, are urban and considered to be too far away from the footprint of the Proposed Project to result in a cumulative impact to terrestrial resources.

Some potential infrastructure projects that involve crossings of tributaries to the Klamath River, including the Ayres Waterline near Grider Creek, and Siskiyou Telephone Fiber Optic Cable Installation near Clear Creek and Dillon Creek, but these are not reported as needing to cross the mainstem Klamath River and are downstream of the Hydroelectric Reach. No relevant development or infrastructure projects have been identified that, in combination with the Proposed Project, would result in significant adverse cumulative impacts to terrestrial resources.

Significance

No significant cumulative impact

3.24.6 Flood Hydrology

The geographic scope for cumulative flood hydrology effects is the same as the Area of Analysis for flood hydrology, as described in in Section 3.6.1 *[Flood Hydrology] Area of Analysis.* This includes the Klamath River downstream of the Oregon-California state line, which lies in portions of three California counties (Siskiyou, Humboldt, and Del Norte) (Figure 3.6-1). Hydrologic characteristics of features in the Upper Klamath Basin in Oregon are considered as they may pertain to potential impacts to stream flows into California.

Existing conditions for flood hydrology are detailed in Section 3.6.2 *[Flood Hydrology] Environmental Setting*, which provides a description of basin hydrology including precipitation; reservoirs; major rivers and tributaries; lakes; springs and seeps providing measurable flow; historical stream flows; and flood hydrology. Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* also provides relevant information related to recent management decisions that dictate Klamath River flows downstream of Iron Gate Dam. These include the 2013 BiOp Flows and the 2017 court-ordered flushing and emergency dilution flows. Section 3.6.2 *[Flood Hydrology] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, flood hydrology resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of flood hydrology resource area effects (Section 3.6). Non-project activity types within the flood hydrology Area of Analysis with the potential for significant cumulative flood hydrology effects are included in Table 3.24-1.

Significance criteria for cumulative flood hydrology effects are the same as defined in Section 3.6.3 *Significance Criteria* for the flood hydrology resource.

Potential Cumulative Impact 3.24-30 Short-term and long-term flood hydrology effects from the Proposed Project in combination with other non-project activities.
Ongoing and reasonably foreseeable aquatic and riparian habitat restoration projects on the Klamath River have the potential for beneficial effects related to flood hydrology. Restoration projects are often designed to enhance river-floodplain connectivity in reaches with high habitat value (e.g., Mid Klamath Floodplain Assessment and Mine Tailing Remediation Plan), which provides accommodation space for flood flows and beneficial locations for depositing fine sediment.

Formal consultation of the 2013 BiOp flows was reinitiated in 2017 to improve management of *Ceratanova shasta (C. shasta)* infection among coho salmon in the Klamath River. Although specific flow details for a new BiOp resulting from re-consultation are speculative at this time, flow changes in the Klamath River due to a new BiOp (or the 2017 court-ordered flushing and emergency dilution flows [U.S. District Court 2017]) are not expected to alter flood hydrology or the FEMA 100-year floodplain in the Area of Analysis. This is because BiOp's specify minimum flow releases and do not impact peak flows during flood events.

Reasonably foreseeable large-scale development projects (see Table 3.24-1) within the flood hydrology Area of Analysis are not located within the 100-year floodplain between the Oregon-California state line and the Humbug Creek confluence, which is the reach where the Proposed Project has the potential to significantly impact the 100-year floodplain. Therefore, there would not be a significant and adverse combined impact of the Proposed Project and other large-scale development projects.

Although the Proposed Project would result in significant and unavoidable adverse impacts due to exposing structures to a substantial risk damage due to flooding (Potential Impact 3.6-3), there are no closely related projects that would, in combination with the Proposed Project, result in further significant and adverse flood hydrology impacts. Thus, there would be no significant cumulative flood hydrology impacts due to the Proposed Project and flow release and floodplain development projects. Additionally, there would be beneficial cumulative effects due to the Proposed Project and habitat restoration projects.

<u>Significance</u>

Beneficial cumulative effects for the combination of the Proposed Project and riverine restoration

No significant cumulative impact for other non-project activities

3.24.7 Groundwater

The geographic scope for cumulative groundwater effects is the same as the Area of
The geographic scope for cumulative groundwater effects is the same as the Area of
Analysis for groundwater, as described in in Section 3.7.1 *[Groundwater] Area of Analysis.* This includes the area within 2.5 miles of Copco No. 1, Copco No. 2, and Iron Gate reservoirs (Figure 3.7-1), which encompasses the area where the likelihood of impacts to groundwater wells due to implementation of the Proposed Project is greatest, as well as areas farther away from the reservoirs where regional groundwater flow data are generally available (Figure 3.7-2). The Area of Analysis lies within Siskiyou County, California and portions of Jackson and Klamath counties, Oregon. Portions of the Area of Analysis within Oregon are considered to the extent that they are likely to influence potential impacts to groundwater resources in California, rather than for potential impacts in Oregon.

Existing conditions for groundwater are detailed in Section 3.7.2 *[Groundwater] Environmental Setting*, which provides a description of regional groundwater conditions and more specific groundwater information in the Area of Analysis. This section characterizes local groundwater conditions in the Area of Analysis by examining well construction parameters in representative cross sections at Copco No. 1 and Iron Gate reservoirs. Section 3.7.2 *[Groundwater] Environmental Setting* also includes consideration of major past or ongoing projects that have impacted, or currently impact, groundwater resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of groundwater resource area effects (Section 3.7). Non-project activity types within the groundwater Area of Analysis with the potential for significant cumulative effects to groundwater are included in Table 3.24-1.

Significance criteria for cumulative groundwater effects are the same as defined in Section 3.7.3 *[Groundwater] Significance Criteria* for the groundwater resource.

Potential Cumulative Impact 3.24-31 Short-term and long-term groundwater effects from the Proposed Project in combination with other non-project activities. There are no reasonably foreseeable large-scale agricultural, residential, or commercial developments proposed within the groundwater Area of Analysis that would have the potential to use substantial amounts of groundwater and thereby lower groundwater levels.

Floodplain restoration in the Copco No. 1 and Iron Gate reservoir footprints that would occur as part of the Proposed Project's Reservoir Area Management Plan (Appendix B: *Definite Plan*) has the potential for beneficial effects related to groundwater. Floodplain restoration projects are often designed to enhance surface water-groundwater interactions that result in more water being stored as groundwater and raising aquifer levels.

As the Proposed Project would not have a significant adverse impact on groundwater and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no cumulative groundwater impacts due to the Proposed Project and agriculture, residential and commercial development, cannabis cultivation, and riverine restoration projects.

Significance

Beneficial cumulative effects for the combination of the Proposed Project and riverine restoration projects

No significant cumulative impact for other non-project activities

3.24.8 Water Supply/Water Rights

The geographic scope for cumulative water supply/water rights effects is the same as the Area of Analysis for water supply/water rights, as described in in Section 3.8.1 *[Water Supply/Water Rights] Area of Analysis.* This includes portions of the Upper, Middle, and Lower Klamath River from the Oregon-California state line downstream to the river's mouth (Figure 3.8-1). The Area of Analysis also includes California irrigators and Wildlife Refuges that receive water through USBR's Klamath Irrigation Project. The Area of Analysis does not include the Shasta, Scott, Salmon, and Trinity rivers because water supply availability and water rights compliance in these rivers are independent of mainstem Klamath water supply and water rights and the Proposed Project.

Existing conditions for water supply/water rights are detailed in Section 3.8.2 *[Water Supply/Water Rights] Environmental Setting*, which provides a description of reservoir capacities, Biological Opinion-related water storage criteria, municipal water supply for the City of Yreka, and other water right holders along the Klamath River in the Area of Analysis. Section 3.8.2 *[Water Supply/Water Rights] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, water supply/water rights.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of water supply/water rights resource area effects (Section 3.8). Non-project activity types within the water supply/water rights Area of Analysis with the potential for significant cumulative effects to water supply/water rights are included in Table 3.24-1.

Significance criteria for cumulative water supply/water rights impacts are the same as defined in Section 3.8.3 *[Water Supply/Water Rights] Significance Criteria* for the water supply/water rights resource.

Potential Cumulative Impact 3.24-32 Cumulative water supply and water rights impacts from the combination of the Proposed Project and other potential non-project activities.

Dam removal associated with the Proposed Project would have no significant impact on the amount of surface water flow available for diversion under existing water rights in the mainstem Klamath River within the Hydroelectric Reach and downstream from Iron Gate Dam (Potential Impact 3.8-1). The Proposed Project would also result in no significant impact with mitigation for releasing stored sediment that could affect water intake pumps and affecting the City of Yreka's municipal water supply (Potential Impacts 3.8-3 and 3.8-4, respectively).

The 2017 flow requirements (i.e., 2013 BiOp Flows plus the 2017 court-ordered flushing and emergency dilution flows) include winter-spring (November 1–April 30) surface flushing flows every year to scour surface riverbed sediments, deep flushing flows between February 15 and May 31 every other year to scour and disturb larger riverbed sediments, and emergency dilution flows between April 1 to June 15, if disease thresholds are exceeded (see Cumulative Potential Impact 3.24-2 for further discussion). As there is sufficient water released from the Lower Klamath Project under existing conditions and from the 2017 flow requirements to satisfy downstream water rights, and a new BiOp would be more likely to increase than decrease flows, there would be no significant cumulative impact to water supply/water rights in the hydroelectric reach or downstream of Iron Gate Dam from the combination of the Proposed Project and the re-consultation of the 2013 BiOp. In a parallel process, USBR has initiated renegotiation for a new Upper Klamath Basin agreement, which would be informed by the final flow requirements under the 2013 BiOp re-consultation regarding water rights among agricultural irrigators, Native American tribes, and environmental uses (Herald and News 2017; Herald and News 2018). However, at this time the outcome of the renegotiation for Upper Klamath Basin water rights is speculative and is not analyzed as part of the cumulative effects.

There are no reasonably foreseeable large-scale agricultural (including cannabis cultivation), development, or riverine restoration projects proposed within the water supply/water rights Area of Analysis (see Table 3.24-1) that have a stated intent to use substantial amounts of Klamath River flows and thereby preclude other existing water right holders from completely exercising their right. It is possible that future restoration and streamflow enhancement projects (e.g., Klamath Basin Restoration Program, Stream Flow Enhancement Program) will have beneficial cumulative effects related to providing more instream flows within the Area of Analysis, but specific effects are speculative at this time.

The KHSA Interim Measure 16 (*Water Diversions*) involves modification of three existing PacifiCorp water rights in the Shovel Creek watershed to move the points of diversion to the mainstem Klamath River (see Table 3.24-1). Moving the points of diversion would not affect other water rights in the Area of Analysis because these are existing, active water rights and flow from the Shovel Creek watershed, which is a tributary to the Klamath River. Thus, diverting the water from the mainstem Klamath instead of higher in the tributaries would not affect the availability of water for downstream users.

Potential sediment releases from non-project activities are assessed in Potential Cumulative Impacts 3.24-2 *[Water Quality]*, 3.24-40 and 3.24-41 *[Geology and Soils]*. No erosion- or turbidity-related impacts are found to be cumulatively considerable. Given that the Proposed Project would not have significant sedimentary impacts on water intake pumps and the City of Yreka's municipal water supply, and other projects would not result in cumulatively considerable erosion, turbidity, or sedimentation impacts, the combined impact to water intake pumps and the water supply would not be cumulatively significant.

Based on the above analysis, there are no closely related projects, including flow release, agricultural, residential, commercial, riverine restoration projects, or other non-project activities, that would, in combination with the Proposed Project, result in adverse cumulative water supply/water rights impacts.

Significance

No significant cumulative impact

3.24.9 Air Quality

The geographic scope for cumulative air quality effects is the same as the Area of Analysis for air quality (Section 3.9.1 *[Air Quality] Area of Analysis*) (Figure 3.9-1). This includes areas within and near the Limits of Work, and Siskiyou County as a whole.

Existing conditions are defined in Section 3.9.2 *[Air Quality] Environmental Setting*. A summary of annual ambient air quality data at a Yreka monitoring station is provided in Table 3.9-1, and the attainment status for air pollutants in Siskiyou County is provided in Table 3.9-2. Siskiyou County is designated as attainment or unclassified for all federal and state ambient air quality standards. Section 3.9.2 *[Air Quality] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, air quality resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of air quality resource area effects (Section 3.9). Non-project activity types within the air quality Area of Analysis with the potential for significant cumulative air quality impacts are included in Table 3.24-1.

Significance criteria for cumulative air quality impacts are the same as defined in Section 3.9.3 *[Air Quality] Significance Criteria*. As indicated in Section 3.9.5 *[Air Quality] Potential Impacts and Mitigation*, the Proposed Project would result in significant and unavoidable air quality impacts from emissions of NOx, PM_{10}, and $PM_{2.5}$ exceeding Siskiyou County Air Pollution Control District emissions thresholds (Potential Impact 3.9-2). Other potential air quality impacts from the Proposed Project, including exposure of sensitive receptors, would not be significant and adverse (Potential Impacts 3.9-1, and 3.9-3 through 3.9-5).

Potential Cumulative Impact 3.24-33: Short-term increases in criteria air pollutant emissions under the Proposed Project in combination with forest and wildfire management projects.

During the Proposed Project construction period (Table 2.7-1), there are proposed wildfire management activities, including prescribed or controlled burning, on national forest lands in Siskiyou County. These projects potentially include the Somes Bar Integrated Fire Management, Crawford Vegetation Management, and Harlan Vegetation Management and Fuels Reduction projects (Table 3.24-1). If these burning activities temporally overlap the Proposed Project construction period and produce substantial quantities of smoke near the Area of Analysis for air quality, there would be a significant cumulative impact due to elevated concentrations of NOx, PM_{10}, and $PM_{2.5}$. Given that the Proposed Project would be well below thresholds for other criteria pollutants, including CO, SO_x, and VOC, significant cumulative impacts are unlikely due to these pollutants. Reasonably foreseeable prescribed or controlled burning activities would, in combination with the Proposed Project, result in significant and adverse emissions of criteria air pollutants within the air quality Area of Analysis. Given the Proposed Project exceeds criteria thresholds for NOx, PM_{10}, and $PM_{2.5,}$ the incremental impact of the Proposed Project to the total emissions would be cumulatively considerable.

<u>Significance</u>

Cumulatively considerable

Potential Cumulative Impact 3.24-34 Short-term increases in criteria air pollutant emissions under the Proposed Project in combination with wildfires.

If wildfires were to produce substantial quantities of smoke near the proposed Limits of Work during the Proposed Project construction and restoration period, there would be an adverse air quality impact. However, if the Area of Analysis is disaster-stricken, it is likely that Proposed Project construction and restoration activities would be placed on hold to protect the health and safety of workers until the wildfire is under control. This is because while the Proposed Project includes a Fire Management Plan that is focused on prevention of fire caused by Proposed Project activities, the Fire Management Plan would also include fire watch activities and fire response methods consistent with related policies and standards in local, county, state, and federal jurisdictions (Section 2.7.8.9 *Fire Management*). The Fire Management Plan process and actions means that any wildfires in Siskiyou County large enough to have a significant impact on air quality and that would temporally overlap with scheduled air quality emissions from the Proposed Project would be unlikely to overlap with actual air quality emissions from the Proposed Project since the latter would be placed on hold; therefore, the cumulative impact would be less than significant.

Significance
No significant cumulative impact

Potential Cumulative Impact 3.24-35 Short-term increases in criteria air pollutant emissions under the Proposed Project in combination with industrial development projects.
There are also two industrial projects in Yreka that have the potential to result in cumulative air quality impacts in combination with the Proposed Project. These include a Nanocellulose Facility (microscopic timber processing) and the Sousa Ready Mix Concrete Batch Plant Project (Table 3.24-1). Both of these projects would be located at least 15 miles southwest of the Limits of Work for the Proposed Project. Development of the nanocellulose facility is currently in the planning stages and it is unknown if the facility would be operational during the construction period for the Proposed Project (Table 2.7-1). An analysis of potential environmental impacts from the proposed nanocellulose facility has not been conducted, and the assessment of potential air quality impacts of nanocellulose production in general is in its infancy. For these reasons, it is currently speculative to determine if potential cumulative air quality impacts would result from operation of the proposed nanocellulose facility during the construction term for the Proposed Project.

In March 2016, a CEQA Initial Study/Mitigated Negative Declaration (IS/MND) was prepared for the Sousa Ready Mix Concrete Batch Plant Project. According to the IS/MND analysis, the batch plant project would result in less than significant air quality impacts during both construction and operation. From review of aerial photography (Google Earth™), it appears that the batch plant was constructed in 2016 and is currently operational. Due to the distance of the plant from the proposed Limits of Work, and the determination of less than significant air quality impacts from operations of the batch plant project, significant cumulative impacts would not result from operation of the batch plant during the construction period for the Proposed Project.

On this basis, the potential air quality impact of the Proposed Project, in combination with industrial development projects, would be less than significant.

Significance
No significant cumulative impact

3.24.10 Greenhouse Gas Emissions

The geographic scope for cumulative GHG effects is the same as the Area of Analysis for GHG emissions and energy effects (Section 3.10.1 *[Greenhouse Gas Emissions] Area of Analysis*) (Figure 3.10-1). This includes areas within California and Oregon where construction activities related to removal of the Lower Klamath Project dam complexes would occur and hence contribute to GHG emissions in Siskiyou County as a whole.

Existing conditions are defined in Section 3.10.2 *[Greenhouse Gas Emissions] Environmental Setting* for this resource. A summary of GHG emission sources in California is provided in Table 3.10-2. Section 3.10.2 *[Greenhouse Gas Emissions] Environmental Setting* provides information about global climate change, the California GHG emissions inventory, and statewide and regional effects of climate change.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of GHG resource area effects (Section 3.10). Non-project activity types within the Area of Analysis with the potential for significant cumulative GHG impacts are included in Table 3.24-1.

Significance criteria for cumulative GHG effects are the same as defined in Section 3.10.3 *[Greenhouse Gas Emissions] Significance Criteria*.

As indicated in Section 3.10.5 *[Greenhouse Gas Emissions] Potential Impacts and Mitigation,* the Proposed Project would not exceed the SCAQMD's GHG emissions significance threshold (Potential Impact 3.10-1), and would not conflict with AB 32, Executive Order S-3-05, SB 32, or the California Renewables Portfolio Standard (RPS) (S-14-08, SB X1-2, and SB 350) (Potential Impact 3.10-2). In particular, with respect to the California RPS, PacifiCorp would reduce its CO_2 emissions for its power generation portfolio over the next two decades and thus would not have a significant impact on GHG emissions. Overall, the Proposed Project would result in no significant GHG emissions impacts. GHG emissions, by nature, represent a cumulative impact; therefore, for CEQA purposes the relative contribution of the Proposed Project and other non-project activities to GHGs are assessed according to the aforementioned legislative guidelines. Although no other reasonably foreseeable future energy-related projects have been identified within the Area of Analysis for GHGs, should these other projects occur they would also be required to comply with AB 32, Executive Order S-3-05, SB 32, and California RPS.

Potential Cumulative Impact 3.24-36 Long-term GHG effects from the Proposed Project in combination with restoration, reforestation, and renewable energy projects.

The Proposed Project would result in no net loss of vegetation, and would not have long-term operational GHG emissions. Additionally, the replacement of hydroelectric energy following the decommissioning of the Lower Klamath Project would not result in a long-term increase in GHG emissions from non-renewable power sources, because PacifiCorp would reduce its CO_2 emissions over the next two decades (Potential Impact 3.10-2). No other closely related energy projects that are not part of existing conditions have been identified within the Area of Analysis. There are habitat enhancement projects and projects to reforest national forest lands burned in recent years by wildfires within the Area of Analysis with the potential for beneficial environmental effects related to GHG emissions (Table 3.24-1), which have the potential to increase carbon sequestration in Siskiyou County. The Proposed Project, in combination with renewable energy, restoration, and reforestation projects, would have no adverse cumulative GHG emissions effects and could have beneficial effects.

Significance

Beneficial cumulative effects

Potential Cumulative Impact 3.24-27 Short-term and long-term GHG effects from the Proposed Project in combination with forest and wildfire management projects.

Prescribed or controlled burning has the potential to generate significant adverse GHG emissions including CO_2 emissions, which have the potential to contribute to global climate change. Non-project fuel reduction activities within the Area of Analysis include the Somes Bar Integrated Fire Management, Crawford Vegetation Management, and Harlan Vegetation Management and Fuels Reduction projects. These projects may generate GHGs in the short term by undertaking prescribed or controlled burning that would overlap in space and time with short-term GHG emissions from the Proposed Project; this is conservatively assessed as a significant cumulative impact. Given that emissions from the Proposed Project would be below significance thresholds (Potential Impacts 3.10-1 and 3.10-2), and would be relatively small in the context of low burning of large acreages for wildfire management, the incremental cumulative impact of the Proposed Project would be less than cumulatively considerable. In the long term, forest management practices have the potential to reduce the occurrence of catastrophic wildfires that would produce significant quantities of GHG emissions, thus could be beneficial for reducing GHG emissions. The Proposed Project would not have long-term operational GHG emissions, and would result in no net loss of vegetation. In the long term, cumulative GHG emissions from the Proposed Project, in combination with forest and wildfire management projects, would be beneficial.

Significance

Not cumulatively considerable in the short term

Beneficial cumulative effects in the long term

Potential Cumulative Impact 3.24-38 Short-term and long-term GHG effects from the Proposed Project in combination with agriculture.

Cumulative GHG-related effects of the Proposed Project, in combination with non-project agriculture, can be considered both during the short-term construction period, and in the long term. Most agricultural projects occurring in the Klamath Watershed are reauthorizations of existing activities (Table 3.24-1), thus are existing conditions. However, zone changes are currently in-process to support additional agricultural land uses (on previously non-agricultural zoned land), including the Cannaworx Zone Change (44 ac) and Kidder Creek Orchard Camp Zone Change (170 ac), both in Siskiyou County. Modifications to policies for agricultural zones to support pastured hog and poultry operations, as well as agritourism, are also underway in Siskiyou County (Table 3.24-1). Such project could have GHG impacts, especially if they result in livestock grazing activities, which have the potential to result in the release of methane (CH_4) from animals, such as cattle, when they feed on grasses. Although GHG emissions are complex, CH_4 has a global warming potential that is 21 times greater than CO_2.

In the short term, GHG emissions during the Proposed Project construction period could overlap with the expansion of non-project agricultural activities above existing conditions within the Area of Analysis. It is speculative to assess the short-term cumulative impact without knowledge of future land uses, but we generally do not consider that the extent of reasonably foreseeable agricultural activities is substantial enough to exceed relevant GHG thresholds in combination with the Proposed Project. For example, the Cannaworx Zone Change would represent an increase of 0.0038 percent of agricultural land in Siskiyou County, and in the unlikely scenario that the entire site was used for grazing, this would represent an increase of 0.0112 percent of grazing land in Siskiyou County (above 2014 agricultural and grazing land areas shown in Table 3.15-1). The Kidder Creek Orchard Camp Zone Change is unlikely to involve any substantial increase of grazing activities, because it supports the expansion of a recreational and spiritual retreat camp. On this basis, there would be no significant short-term cumulative impact from the Proposed Project in combination with other closely related agricultural projects.

In the long term, the Proposed Project includes the transfer of PacifiCorp lands immediately surrounding the Lower Klamath Project ("Parcel B lands") from PacifiCorp to the KRRC prior to dam removal, and then to the respective states (i.e., California, Oregon), as applicable, or to a designated third-party transferee, following dam removal (Section 2.7.11 *Land Disposition and Transfer*). The Parcel B lands would thereafter be managed for public interest purposes, which could include: open space, active wetland and riverine restoration, tribal mitigation, river-based recreation, grazing, and potentially other uses. It is too speculative to determine which land uses would occur in any particular place, or over what area, on the Parcel B lands. The occurrence of agriculture on Parcel B lands, and expansion of non-project agricultural activities within the Area of Analysis, could be associated with an increase in GHG-emitting livestock grazing activities, resulting in an adverse cumulative impact. However, with limited knowledge of future land uses and complex benefits and impacts, it is speculative to qualitatively assess the long-term GHG emissions from Proposed Project agriculture and other agricultural activities within the Area of Analysis. Nevertheless, given the miniscule percentage changes of grazing lands for reasonably foreseeable agricultural projects described in the prior paragraph, it is likely that any establishment of grazing on Parcel B lands in the long term would also represent a relatively small portion of the total grazing land area in Siskiyou County. As there is unlikely to be a substantial change in grazing land area, there is no foreseeable significant cumulative impact in the long term.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-39 Long-term GHG effects from the Proposed Project in combination with industrial development projects.

Along with the wildfire management and agricultural activities, there are also two industrial projects in Yreka, CA that have the potential to result in cumulative GHG impacts in combination with the Proposed Project. These include a Nanocellulose Facility (microscopic timber processing) and the Sousa Ready Mix Concrete Batch Plant Project. Development of the Nanocellulose Facility is currently in the early planning stages and it is unknown if, or when, the facility will be constructed or become operational. An analysis of potential environmental impacts from the proposed facility has not been conducted. Depending on the process used for nanocellulose production, there is the potential for the generation of significant GHG emissions due to, among other factors, energy use and wood pulp production. Most processes used to produce nanocellulose materials are energy intensive, with the potential to result in substantial GHG emissions depending on the available energy supply (e.g., fossil-fuel vs. renewable energy sources). The production of wood pulp, which is a common starting material for nanocellulose materials, results in significant emissions of both biogenic and non-biogenic CO_2. As the production capacity of the proposed facility and the process that would be used to produce nanocellulose materials are unknown, it is currently speculative to determine if potential cumulative GHG impacts would result from operation of the proposed Nanocellulose Facility in combination with the Proposed

Project. In March 2016, a CEQA Initial Study/Mitigated Negative Declaration was prepared for the Sousa Ready Mix Concrete Batch Plant Project. According to the analysis in the CEQA document, the GHG emissions from construction and operation of the batch plant would result in less than significant impacts. From review of aerial photography, it appears that the batch plant was constructed in 2016 and is currently operational. Because the batch plant project and Proposed Project were determined to individually result in less than significant GHG impacts, significant cumulative impacts would likely not result from the Proposed Project in combination with the operation of the batch plant.

Significance
No significant cumulative impact

3.24.11 Geology, Soils, and Mineral Resources

The Area of Analysis for geology and soils includes the riverbed and reservoir banks at the sites of the Iron Gate, Copco No. 1, and Copco No. 2 dams and associated facilities, as well as the riverbed and adjacent banks along the Klamath River from the Oregon-California state line to the Pacific Ocean, including the Klamath River Estuary.

Existing conditions for geology, soils, and mineral resources are described in Section 3.11.2 *[Geology, Soils, and Mineral Resources] Environmental Setting*. The Klamath River traverses approximately 260 river miles. With a watershed area of approximately 15,722 mi^2, the Klamath River produces the second largest average annual runoff (Kruse and Scholz 2006) and sediment flux (Willis and Griggs 2003) of California's rivers. The cumulative average annual sediment delivery from the Klamath River to the ocean was estimated to be 6,237,500 tons/yr (Stillwater Sciences 2010) (Table 3.11-3). Additionally, the four Lower Klamath Project reservoirs currently store approximately 13.15 million cubic yards (yd^3) of sediment (Table 3.11-4) (USBR 2012). Section 3.11.2 *[Geology, Soils, and Mineral Resources] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, geology, soils, and mineral resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of geology, soils, and mineral resources area effects (Section 3.11). Non-project activity types within the geology and soils Area of Analysis with the potential for significant cumulative geology and soil impacts are included in Table 3.24-1.

Significance criteria for geology and soil cumulative impacts are the same as defined in Section 3.11.3 *[Geology, Soils, and Mineral Resources] Significance Criteria*.

Potential Cumulative Impact 3.24-40 Short-term soil disturbance, erosion, and sedimentation effects from the Proposed Project in combination with other construction projects.
The Proposed Project would result in soil disturbance, erosion, and sediment deposition within the Area of Analysis for geology, soils, and mineral resources, as summarized below. The Proposed Project would not have a significant soil disturbance and erosion impact associated with heavy vehicle use, excavation, and grading, because an Erosion Control Plan would set out best management practices to be followed on-site (Potential Impact 3.11-2). The Proposed Project would also not have a significant sedimentation

impact downstream of the Lower Klamath Project reservoirs, or the sedimentation would be beneficial (Potential Impact 3.11-5). It is possible that some projects involving construction activities could overlap with the Proposed Project, including restoration and infrastructure projects, and these would have temporary, short-term soil disturbance, erosion, and sedimentation impacts (Table 3.24-1). Potential future overlapping riverine restoration projects include projects under the Klamath Basin Restoration Program and Gravel Enhancement below Iron Gate Dam for Salmon. Some potential infrastructure projects that involve crossings of tributaries to the Klamath River, including the Ayres Waterline near Grider Creek, and Siskiyou Telephone Fiber Optic Cable Installation near Clear Creek and Dillon Creek, but these are not reported as needed to cross the mainstem Klamath River and are downstream of the Hydroelectric Reach. No potential large-scale development projects identified in Table 3.24-1 are near the mainstem Klamath River. Section 402 of the Clean Water Act requires a *General Stormwater National Pollution Discharge Elimination System Permit for Construction Activities* across Oregon and California, and an *Erosion Control Plan* is required together with this Permit. Because infrastructure and development projects near the mainstem Klamath are not expected to overlap with the Proposed Project, and other construction-related disturbances including construction for riverine restoration, would be subject to the same rigorous erosion planning and prevention as the Proposed Project, there would not be a significant cumulative erosion impact from construction activities.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-41 Short-term soil disturbance, erosion, and sedimentation effects from the Proposed Project in combination with mining, forest and wildfire management, and agriculture.

Non-construction sediment-generating activities, such as wildfire, forest and wildfire management, mining and agriculture, would be subject to separate planning standards and requirements than for construction activities assessed in Potential Cumulative Impact 3.24-42 above. Wildfires are a naturally recurring event in the Klamath Basin, and have the potential to result in substantial erosion and sediment delivery if rainfall events occur before vegetation reestablishes. Increased sediment delivery would be most likely if a wildfire occurred late in the fire season (fall), and a combination of the Proposed Project and rain storms occurred shortly following the fire. As discussed in Potential Cumulative Impact 3.24-4, this could increase suspended sediment and sedimentation additional to the Proposed Project, and the water quality impact could be significant. The combination of geology and soils impacts under the Proposed Project and wildfires would also be significant, if temporal and spatial overlap occurs. However, given that geology and soil impacts, including soil disturbance, erosion, and sedimentation impacts, associated with the Proposed Project in isolation would not be significant (see Potential Impacts 3.11-2, 3.11-3, 3.11-5, 3.11-6), and these impact would likely be small compared with flooding on large areas of bare ground exposed by wildfire, the incremental impact of the Proposed Project would not be cumulatively considerable.

Most known forest and wildfire management projects are not close to the mainstem Klamath River, except the Somes Bar Integrated Fire Management Project (approximately 90 miles downstream of Humbug), and Crawford Vegetation Management Project (approximately 70 miles downstream of Humbug). Most mining projects described in the assessment of existing conditions for the Proposed Project are withdrawal or remediation projects, or are situated in tributaries far from the Hydroelectric Reach, apart from the new Plan of Operations for the existing Brooks Mine. The new plan of operations for the Brooks Mine (Table 3.24-1) is near the expected hydrologic and sedimentation footprint from Lower Klamath Project dam removal, which extends through the Hydrologic Reach and the Middle Klamath River from Iron Gate Dam to Humbug Creek. Most agricultural projects, including cannabis cultivation projects, are also captured by existing conditions, or are situated far from the Hydroelectric Reach, except for the adopted Cannaworx Zone Change near Humbug. The Cannaworx Zone Change would convert Open Space to Non-Prime Agricultural zoned land, thus supporting agricultural activities on previously agriculture-free land. Based on the above information, the soil disturbance, erosion, and sedimentation impact of the Proposed Project, in combination with forest and wildfire management, mining-related activities, and agricultural activities, would not be cumulatively significant.

Significance

Not cumulatively considerable for wildfire

No significant cumulative impact for forest and wildfire management, mining-related activities, and agricultural activities

Potential Cumulative Impact 3.24-42 Short-term hillslope instability, effects to earthen dam embankments, and/or bank erosion from the Proposed Project in combination with other potential non-project activities.

Slope stability analyses conducted for the Proposed Project indicate that segments of the Copco No. 1 Reservoir rim have a potential for slope failure that could impact existing roads and/or private property. These areas include approximately 3,700 linear feet of slopes along Copco Road and approximately 2,800 linear feet of slope adjacent to private property (Appendix B: *Definite Plan*). Up to eight parcels in these areas have existing habitable structures that could potentially be impacted. The impact of the Proposed Project on hillslope instability in reservoir rim areas would be significant. Implementation of Mitigation Measure GEO-1 would reduce the cumulative impact to less than significant. No other projects have been identified that would cause hillslope instability along the rim of Copco No. 1 Reservoir (or the rims of Iron Gate or Copco No. 2 reservoirs) (Table 3.24-1); therefore, there would be no cumulative impact.

Analyses of embankment stability during drawdown at the earthen dams (i.e., Iron Gate Dam and J.C. Boyle Dam) indicate that the proposed reservoir drawdown rates would not result in substantial embankment instability (Appendix B: *Definite Plan*). Small, shallow slumping along the upstream embankment slopes due to the potential strength loss of surficial materials during drawdown would not threaten the structural integrity of the embankments or deliver a substantial amount of sediment. No other projects have been identified that would cause embankment instability at Iron Gate Dam and J.C. Boyle Dam (Table 3.24-1); therefore, there would be no cumulative impact related to embankment stability.

Drawdown flow rates for the Proposed Project are similar to existing and historical flow rates, and would be adjusted according to the water year type, thus substantial bank erosion is not expected (Potential Impact 3.11-4). As discussed in Potential Impact 3.24-2 *[Water Quality]*, 2017 flow requirements (i.e., 2013 BiOp Flows plus the court-ordered flushing and emergency dilution flows) are within the range of flows modeled under the Proposed Project; therefore, there would not be any cumulative impact related to bank erosion.

Significance
Not cumulatively considerable with mitigation for short-term instability in reservoir rim areas

No significant cumulative impact for instability of earthen embankments or bank erosion downstream of reservoirs

Potential Cumulative Impact 3.24-43 Short-term seismic activity effects from the Proposed Project in combination with other potential non-project activities.
The nearest active fault is approximately five miles from the dams proposed for removal. These faults are reported not to have moved within the past 1.5 million years and, therefore, are considered inactive (Personius et al. 2003). Drawdown of reservoirs of this size is not expected to induce seismicity. Reservoir draining is also not expected to cause volcanic activity due to the distance from volcanic hazards (e.g., Mount Shasta). No other closely related projects have been identified that are likely to induce seismic or volcanic activity. Based on the above information, the short-term seismic activity effects from the Proposed Project, in combination with other potential non-project activities, would not be cumulatively significant.

Significance
No significant cumulative impact

Potential Cumulative Impact 3.24-44 Long-term mineral resources effects from the Proposed Project in combination with mining activities.
Diatomite deposits near the southern downstream shore of Copco No. 1 Reservoir are currently inaccessible for extraction purposes due to their location in the reservoir and existing erosion. Under the Proposed Project, land ownership within the reservoir areas would be transferred to the KRRC and then to the State of California, or to a designated third-party transferee in the case of Copco No. 1 Reservoir (Section 2.7.11 *Land Disposition and Transfer*). The lands would thereafter be managed for public interest purposes, which could include open space, active wetland and riverine restoration, river-based recreation, grazing, and potentially others. It is likely that the accessibility of diatomite deposits will be a continuation of the existing condition, and effects from the Proposed Project, in combination with other potential mining activities (Table 3.24-1), would not be cumulatively significant.

Significance
No significant cumulative impact

3.24.12 Historical Resources and Tribal Cultural Resources

The geographic scope for cumulative historical and tribal cultural resources effects is the same as the Area of Analysis for historical and tribal cultural resources, as described in in Section 3.12.1 *[Historical and Tribal Cultural Resources] Area of Analysis.* This includes the combined area of analysis (Figure 3.12-1) and its four subareas[176] (Figures 3.12-2 through 3.12-5). The four subareas allow for individual impact analyses specific to geographic location (e.g., reservoir footprint, riverside location) and Proposed Project activity timing (e.g., pre-dam removal, reservoir drawdown, restoration activities). While the subareas overlap, this has no bearing on the analysis of any historical or tribal cultural impact, since the subareas are considered independently by impact.

Existing conditions for historical and tribal cultural resources are detailed in Section 3.12.2 *[Historical and Tribal Cultural Resources] Environmental Setting*. Archaeological investigations have confirmed nearly 10,000 years of human presence in the Mid and Upper Klamath Basins. The Klamath River flows through several culture regions in California's Northwest Coast, the Great Basin, and portions of the Columbia Plateau. These unique cultural regions have been occupied by Native American Tribes recognized now as part of the Klamath Tribes, Quartz Valley Indian Reservation, Shasta Nation, Shasta Indian Nation, Karuk, the Hoopa Valley Tribe[177], Resighini Rancheria, and the Yurok Tribe. The discovery of gold in 1848 was the catalyst that caused a dramatic alteration of both Native American and Euro American cultural patterns in California. Section 3.12.2 *[Historical and Tribal Cultural Resources] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, historical and tribal cultural resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of historical and tribal cultural resources effects (Section 3.12). Non-project activity types within the historical and tribal cultural resources Area of Analysis with the potential for significant cumulative effects to historical and/or tribal cultural resources are included in Table 3.24-1.

Significance criteria for cumulative historical and tribal cultural resources are the same as defined in Section 3.12.3 *[Historical and Tribal Cultural Resources] Significance Criteria* for the resource.

Potential Cumulative Impact 3.24-45 Long-term effects on the Klamath River fishery tribal cultural resource of the Proposed Project in combination with restoration, flow enhancement, and water quality improvement projects.
The Proposed Project would benefit the cultural riverscape and ecosystem health, including tribal fisheries resources, in the long term by dam removal and elimination of hatchery production (Potential Impact 3.12-9). The Proposed Project would also benefit the ability of tribes to use the Middle and Lower Klamath River for ceremonial and other purposes because of reductions in blue-green algae concentrations (Potential Impact 3.12-10). Other restoration, flow enhancement, and water quality improvement projects along the Klamath River and its tributaries (creeks and rivers) are anticipated to improve

[176] *Subarea 1* – Proposed Project Limits of Work inclusive of known cultural sites that lie partially within and partially outside the Limits of Work; *Subarea 2* − Post-dam removal altered 100-year floodplain along the 18-river mile stretch of the Middle Klamath River downstream of Iron Gate Dam (RM 193.1) to the confluence with Humbug Creek (RM 174); *Subarea 3* – 0.5-mile buffer on either side of the Hydroelectric Reach, Middle Klamath River, and Lower Klamath River encompassing the existing conditions and post-dam removal 100-year floodplain; *Subarea 4* – Parcel B lands.
[177] The term Hupa describes the Hupa People. The term Hoopa is used to reference the Hoopa Valley place or the tribal government.

the Klamath River fishery tribal cultural resource by enhancing water quality (e.g., water temperature, suspended sediments, nutrients, dissolved oxygen, pH, chlorophyll-a, and algal toxins) and habitat through riparian habitat restoration, placement of off-channel habitat features, floodplain restoration, incorporation of large wood into tributaries to the Klamath River, and increases in stream flow. Reasonably foreseeable restoration projects that would occur within the post-dam removal altered 100-year floodplain between Iron Gate Dam and Humbug Creek, corresponding to *Subarea 2* (Figure 3.12-3) of the historical and tribal cultural resources Area of Analysis, or the existing conditions and post-dam removal 100-year floodplain of the Klamath River, corresponding to *Subarea 3* (Figure 3.12-4) of the historical and tribal cultural resources Area of Analysis, are included in Table 3.24-1). Note that this potential effect is not relevant to other historical and tribal cultural resources Area of Analysis subareas (i.e., *Subarea 1* and *Subarea 4*).

Restoration, flow enhancement, and water quality improvement projects would increase the amount of cold water flowing in the river, improving water temperature conditions for salmonids, while the Proposed Project would improve water temperature conditions by returning more natural seasonal and daily variations. Increases in river flows from restoration, flow enhancement, and water quality improvement projects would also be beneficial for water quality by diluting chlorophyll-*a* and algal toxins concentrations. The Proposed Project also would decrease high seasonal chlorophyll-*a* concentrations and periodically high algal toxin concentrations by eliminating reservoir environment that currently supports growth conditions for toxin-producing nuisance blue-green algal species such as *Microcystis aeruginosa.* Overall, the Proposed Project, in combination with restoration, flow enhancement, and water quality improvement projects, would result in beneficial cumulative effects on the Klamath River fishery tribal cultural resource within *Subarea 2* and *Subarea 3* of the historical and tribal cultural resources Area of Analysis.

Significance

Beneficial cumulative effects in *Subarea 2* and *Subarea 3* of the historical and tribal cultural resources Area of Analysis

Potential Cumulative Impact 3.24-46 Short-term historical and tribal cultural resources effects of the Proposed Project in combination with 2017 court-ordered flushing and emergency dilution flows.

The 2013 BiOp Flows have been analyzed under the individual resource sections for the Proposed Project. Potential Impact 3.24-2 in Section 3.24.2 *Cumulative Water Quality Effects* provides background and context regarding agency re-consultation on the 2013 BiOp. For the reasons set out in Potential Impact 3.24-2, this analysis only considers the 2017 court-ordered flow requirements, which were imposed after issuance of the Notice of Preparation (i.e., are not part of the existing conditions), and are a reasonably foreseeable flow condition; this analysis does not consider the potential new BiOp.

The existing 100-yr floodplain in the Middle Klamath River downstream of Iron Gate Dam between RM 190 and 171, defined as *Subarea 2*, would increase slightly under the Proposed Project, and associated flooding and erosion may have a significant and unavoidable impact on historical and tribal cultural resources along this reach of the Klamath River, (Potential Impacts 3.12-3 and 3.12-14). In other reaches of the Klamath River, the floodplain is not expected to change (Potential Impacts 3.12-3 and 3.12-14). There are no closely related development projects that would, in combination with the

Proposed Project, have a significant and adverse impact on flooding in *Subarea 2* (Table 3.24-1), where the floodplain is expected to increase under the Proposed Project. During the period when the Proposed Project would occur, the 2017 flow requirements (i.e., 2013 BiOp Flows plus the 2017 court-ordered flushing and emergency dilution flows) would be in effect (see Cumulative Impact 3.24-1 for additional detail). However, these flow requirements are not sufficiently high as to increase flooding risk, thus there would be no cumulative flooding and/or erosion impacts to historical and tribal cultural resources located within the 100-year floodplain.

As mentioned in Impact 3.24-45 above, the Proposed Project would benefit the cultural riverscape and ecosystem health, including tribal fisheries resources, by dam removal and elimination of hatchery production (Potential Impact 3.12-9). The 2017 flow requirements would improve Klamath River fishery tribal cultural resource by reducing the incidence of fish disease (see Section 3.3.5.5 *Fish Disease and Parasites*), and in combination with the removal of upstream migration barriers (i.e., the Lower Klamath Project dams) and improvements to the quality of riverine habitat in the Middle Klamath River and the Hydroelectric Reach (see Section 3.3.5.8 *Aquatic Habitat*), there would be a cumulative beneficial effect on the fishery tribal cultural resource.

Significance

No significant cumulative impact related to short-term flooding and/or erosion of tribal cultural resources located within the 100-year floodplain

Beneficial cumulative effects on fishery tribal cultural resource in the short term

Potential Cumulative Impact 3.24-47 Short-term and/or long-term historical and tribal cultural resources effects from the Proposed Project in combination with development projects.

Tribal Cultural Resources

Significant and unavoidable short-term ground-disturbing construction-related impacts on archaeological and non-archaeological tribal cultural resources (TCRs) would occur with mitigation for the 4 to 8-year period of dam removal and restoration activities under the Proposed Project (Potential Impacts 3.12-1, 3.12-4, 3.12-5). The ground-disturbing activities would occur within *Subarea 1* of the historical and tribal cultural resources Area of Analysis (Figure 3.12-2). Additionally, the Proposed Project would result in potential significant shifting and exposure of existing tribal cultural resources within the reservoir footprints and Klamath River (Potential Impacts 3.12-2, 3.12-3, and 3.12-7) during and following reservoir drawdown. Following reservoir drawdown, the Proposed Project would include floodplain restoration activities in the reservoir footprints and upland areas of *Subarea 1* (Appendix B: *Definite Plan – Appendix H*). There are no reasonably foreseeable large-scale development projects (see Table 3.24-1) within *Subarea 1* that that would, in combination with the Proposed Project, result in significant and adverse impacts to archaeological and non-archaeological TCRs.

Following dam removal, transfer of Parcel B lands would occur under the Proposed Project, where Parcel B lands correspond to *Subarea 4* of the historical and tribal cultural resources Area of Analysis (Figure 3.12-5). This would result in public interest land management on these lands, which could include open space, active wetland and riverine restoration, tribal mitigation, river-based recreation, grazing, and potentially other uses. While it is too speculative to determine which land uses would occur in any particular place within the Parcel B lands, there are no reasonably foreseeable large-scale development projects currently identified within the Parcel B lands (Table 3.24-1) and it is highly unlikely that public interest land management would include large-scale development projects.

Overall, there would be no cumulative impacts to tribal cultural resources in *Subarea 1* and *Subarea 4* due to the combination of the Proposed Project and development projects. Note that this potential effect is not relevant to other historical and tribal cultural resources Area of Analysis subareas (i.e., *Subarea 2* and *Subarea 3*).

Historical Built Environment
The Proposed Project would result in significant adverse impacts to Copco No. 1 Dam, Copco No. 2 Dam, and Iron Gate Dam, their associated hydroelectric facilities, and the Klamath River Hydroelectric Project District (Potential Impact 3.12-11) because these historic period complexes would be removed. The Klamath River Hydroelectric Project District is located within *Subarea 1* of the historical and tribal cultural resources Area of Analysis (Figure 3.12-2). There are no reasonably foreseeable large-scale development projects (see Table 3.24-1) within *Subarea 1* that that would, in combination with the Proposed Project, result in a combined significant impact to the historical built environment.

Significant and unavoidable short-term ground-disturbing construction-related impacts on historic-period archaeological resources would occur with mitigation for the 4 to 8-year period of dam removal and restoration activities under the Proposed Project (Potential Impacts 3.12-12, 3.12-15, 3.12-16). The ground-disturbing activities would occur within *Subarea 1* of the historical and tribal cultural resources Area of Analysis (Figure 3.12-2). There are no reasonably foreseeable large-scale development projects (see Table 3.24-1) within *Subarea 1* that that would, in combination with the Proposed Project, result in significant and adverse impacts to historic-period archaeological resources.

Significance
No significant cumulative impact in *Subarea 1* and *Subarea 4* of the historical and tribal cultural resources Area of Analysis

3.24.13 Paleontologic Resources

The Area of Analysis for paleontologic resources is the region within and adjacent to the Klamath River 100-year floodplain, from the Oregon-California state line to the Klamath River's mouth near Requa, California (Figure 3.13-1). This includes the area within 1,000 feet of FEMA Flood Zones A and AE, or downstream of Iron Gate Dam within 1,000 feet of the National Hydrography Dataset Klamath River centerline, and upstream of Iron Gate Dam within five miles of the Klamath River centerline.

Existing conditions for paleontologic resources are as described in Section 3.14.2 *[Paleontologic Resources] Environmental Setting*. The majority of bedrock deposits within the Area of Analysis for paleontologic resources are not fossil-bearing units. Two mapped geologic units that contain paleontologic resources are present within the Area of Analysis: (1) the unnamed diatomite deposit at Copco No. 1 Reservoir; and (2) the Hornbrook Formation. The diatomite deposit is determined to be of Low Paleontologic Potential. The fossils in the Hornbrook Formation are documented to include megafossils and microfossils, but it is not known if the fossil abundance varies spatially within this geologic unit. The Klamath River cuts across the Hornbrook Formation in the region of Hornbrook, California, along approximately three river miles (Figure 3.13-2). Sub-units within the Hornbrook formation are described in Section 3.14.2 *[Paleontologic Resources] Environmental Setting.* Section 3.14.2 also includes consideration of major past or ongoing projects that have impacted, or currently impact, paleontologic resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of paleontologic resource area effects (Section 3.13). Non-project activity types within the paleontologic Area of Analysis with the potential for significant cumulative paleontologic impacts are included in Table 3.24-1.

Significance criteria for cumulative geology and soils impacts are the same as defined in Section 3.13.3 *[Paleontologic Resources] Significance Criteria*.

Potential Cumulative Impact 3.24-48 Long-term paleontologic resources effects from the Proposed Project in combination with other non-project activities.
The Hornbrook Formation is classified as Low Paleontological Potential in Potential Impact 3.13-1, and river discharges during the Proposed Project drawdown would have a low likelihood of downcutting or erosion of the Hornbrook Formation. Thus, there would be no significant impact of the Proposed Project on paleontologic resources. As there are no closely related projects that would, in combination with the Proposed Project, result in cumulative flood hydrology impacts (see Section 3.24.6 *Cumulative Flood Hydrology Effects*) there would be no cumulative downcutting and erosion impacts related to altered flood flows within the Klamath River. No other mining, infrastructure, or restoration projects that would involve excavation into the Hornbrook Formation have been identified (Table 3.24-1). As the Proposed Project would have no significant impact on paleontologic resources, and there are no closely related projects that would have a significant and adverse impact on paleontologic resources, there would be no cumulative impact from the Proposed Project in combination with other projects identified above.

Significance
No significant cumulative impact

3.24.14 Land Use and Planning

The Area of Analysis for land use and planning is defined as the Project Boundary, including the Limits of Work and Parcel B lands (Figure 2.2-5).

Existing conditions for land use and planning are as described in Section 3.14.2 *[Land Use and Planning] Environmental Setting*. PacifiCorp owns the majority of the land within the Project Boundary (Figure 2.2-5), BLM manages 59.3 acres within the Proposed Project area, and most of the land surrounding Copco No. 1 Reservoir is privately owned. The majority of the Area of Analysis for land use and planning is categorized as Open Space – Natural Resources, which includes activities such as timber production, grazing land, and developed and dispersed recreational uses. Public lands are managed by BLM, USDA Forest Service, and other agencies. In the Area of Analysis for this resource, there are residential developments along portions of the Copco No. 1 Reservoir. There are commercial and industrial developments in some rural areas downstream from Iron Gate Dam. Copco No. 1 Dam, Copco No. 2 Dam, Iron Gate Dam, and Fall Creek facilities are described in Section 3.14.2 *[Land Use and Planning] Environmental Setting*. Downstream from Iron Gate Dam are several rural developments located along the Klamath River shoreline. Section 3.14.2 *[Land Use and Planning] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, land use resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of land use and planning resource area effects (Section 3.14). Non-project activity types within the land use and planning Area of Analysis with the potential for significant cumulative land use and planning impacts are included in Table 3.24-1.

Significance criteria for cumulative aquatic resources impacts are the same as defined in Section 3.14.3 *[Land Use and Planning] Significance Criteria*.

Potential Cumulative Impact 3.24-49 Short-term or long-term physical division of communities from the Proposed Project in combination with other potential non-project activities.

The Proposed Project would not physically divide an established community by interrupting road access for supplies and services (Potential Impact 3.14-1). Although installation of livestock exclusion fencing is included in the Proposed Project, fencing would only be placed where grazing land abuts planned reservoir restoration areas and would be installed to replace the existing function of the Lower Klamath Project reservoirs as natural barriers (Potential Impact 3.14-1). No other projects have been identified within the Area of Analysis that could create an adverse physical division that interrupts supplies and services. Although there are agricultural projects identified in Table 3.24-1, none of them are within the Area of Analysis for land use and planning, and most are situated farther downstream. Some restoration projects are potentially within the Area of Analysis for land use and planning, including: the Klamath Basin Restoration Program projects and the Mid Klamath Coho Rearing Habitat Enhancement Project; however, these restoration projects do not specify that they would include riparian fencing. Forest and wildfire management projects that create fuel breaks, and road repair and construction projects, could both have beneficial cumulative effects by creating new roads. As the Proposed Project would not have a significant adverse impact on the physical division of communities, and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no cumulative physical division impacts due to the Proposed Project and other closely related projects.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-50 Short-term or long-term land use resources effects from the Proposed Project in combination with other non-project activities.

The Proposed Project does not conflict with any land use plan, policy, or regulation, nor any Habitat Conservation Plan (HCP) or Natural Community Conservation Plan (NCCP) (Potential Impact 3.14-2). Other closely related, reasonably foreseeable projects would be subject to their own planning processes to assess conflicts with adopted plans, policies, and regulations. There is no identified potential for a significant cumulative impact due to conflict with plans, policies, regulations, HCPs, or NCCPs. As the

Proposed Project would not have a significant adverse impact on land use, and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no cumulative land use impacts due to the Proposed Project and other closely related projects.

Significance

No significant cumulative impact

3.24.15 Agriculture and Forestry

For agricultural and forestry resources, the Area of Analysis includes all lands within the Project Boundary (Figure 2.2-5), plus a half-mile buffer around Copco No. 1 Reservoir (Figure 3.15-1).

Existing conditions for agriculture and forestry resources are as described in Section 3.15.2 *[Agriculture and Forestry Resources] Environmental Setting*. Most of the land in the Area of Analysis is classified by the DOC as Grazing Land, with a small area of Unique Farmland located approximately two miles south of Copco No. 1 Reservoir (Figure 3.15-1). Parcels zoned by Siskiyou County for Agriculture-Grazing are located within the Area of Analysis to the north and south of Copco No. 1 Reservoir (Figure 3.14-1). There are a number of parcels located immediately upstream of Copco No. 1 Reservoir that are used primarily for grazing and hay production. The DOC (2016c) identified these lands as Prime Farmland or Farmland of Statewide Importance (Figure 3.15-1). No Williamson Act parcels nor lands zoned Forest Resources under the Siskiyou County General Plan occur within the Area of Analysis. Section 3.15.2 *[Agriculture and Forestry Resources] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, agriculture and forestry resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of agriculture and forestry resource area effects (Section 3.15). Non-project activity types within the agriculture and forestry Area of Analysis with the potential for significant cumulative impacts are included in Table 3.24-1.

Significance criteria for cumulative agricultural and forestry impacts are the same as defined in Section 3.15.3 *[Agriculture and Forestry] Significance Criteria*.

Potential Cumulative Impact 3.24-51 Short-term and long-term effects to agricultural resources from the combination of the Proposed Project and agricultural and rezoning projects.

The Proposed Project includes the transfer of PacifiCorp lands immediately surrounding the Lower Klamath Project ("Parcel B lands") from PacifiCorp to the KRRC prior to dam removal, and then to the respective states (i.e., California, Oregon), as applicable, or to a designated third-party transferee, following dam removal (Section 2.7.11 *Land Disposition and Transfer*). The Parcel B lands would thereafter be managed for public interest purposes, which could include: open space, active wetland and riverine restoration, tribal mitigation, river-based recreation, grazing, and potentially other uses. It is speculative to determine which land uses would occur in any particular place, or over what area, on the Parcel B lands.

Most agricultural projects occurring in the Klamath Watershed are reauthorizations of existing activities (Table 3.24-1), thus are captured by the Proposed Project existing conditions. However, zone changes are currently in-process to support additional agricultural land uses (on previously non-agricultural zoned land), including the Cannaworx Zone Change and Kidder Creek Orchard Camp Zone Change, both in Siskiyou County. Modifications to policies for agricultural zones to support pastured hog and poultry operations, as well as agritourism, are also underway in Siskiyou County (Table 3.24-1). The Kidder Creek Orchard Camp Zone Change is situated outside of the Area of Analysis. The adopted Cannaworx Zone Change is within the Area of Analysis near Humbug; it will convert Open Space to Non-Prime Agricultural zoned land, thus supporting agricultural activities on previously agriculture-free land. This would have a beneficial effect on the agricultural resource. As the Proposed Project would not have a significant adverse impact on agricultural resources, and there is only one closely related (beneficial) non-project action, there would be no significant cumulative agricultural impacts due to the Proposed Project.

Significance
No significant cumulative impact

Potential Cumulative Impact 3.24-52 Short-term and long-term effects to forestry resources from the combination of the Proposed Project and forest and wildfire management.
The Proposed Project would have no significant impact on forest lands (Potential Impacts 3.15-2, 3.15-3, and 3.15-4 *[Agriculture and Forestry Resources]*. Non-project activities relating to forest health and fuels management (Table 3.24-1) are proposed in the Klamath Basin, which would result in benefits to forestry resources by reducing the potential for catastrophic stand-replacing wildfire and faster late-successional timber development. However, these projects are not proposed within the agriculture and forestry Area of Analysis. As the Proposed Project would not have a significant adverse impact on forestry resources, and there are no closely related forest or wildfire management projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no significant cumulative forestry resource impacts.

Significance
No significant cumulative impact

Potential Cumulative Impact 3.24-53 Short-term and long-term effects to forestry resources from the combination of the Proposed Project wildfire.
As mentioned above, the Proposed Project would have no significant impact on forest lands (Potential Impacts 3.15-2, 3.15-3, and 3.15-4 *[Agriculture and Forestry Resources]*. Wildfires regularly occur within the Klamath Basin, with multiple fires occurring in 2016 through 2018 (Table 3.24-1). Under climate change, forests will be more susceptible to extreme wildfires, with an almost 50 percent increase in the frequency of extreme wildfires that burn over approximately 25,000 acres, and a 77 percent increase in the average area burned statewide by the end of the century (Bedsworth et al. 2018). Large fires can burn hundreds to thousands of acres; for example, in 2016, 844 acres were burned in Siskiyou County. That said, wildfires are a natural occurrence in California and low-burning fires can improve forest health. Given that the Proposed Project would not have significant impacts on forest lands, there would be no significant cumulative impact to forests when the Proposed Project is

considered together with substantial changes that would result if a wildfire were to occur in the Area of Analysis.

Significance
No significant cumulative impact

3.24.16 Population and Housing

The Area of Analysis for population and housing extends beyond the Project Boundary (Figure 2.2-5) to encompass the following urban and rural communities in California: the community of Hornbrook, the City of Yreka, and the residential rural areas near Copco No.1, Copco No. 2, and Iron Gate reservoirs. Existing conditions for population and housing are described in Section 3.16.2 *[Population and Housing] Environmental Setting*. Within the population and housing Area of Analysis, there are approximately 12 residences proposed for demolition that are currently owned by PacifiCorp and are for use by workers maintaining the dams or other PacifiCorp properties. Section 3.16.2 *[Population and Housing] Environmental Setting* presents Siskiyou County census data, along with data for Yreka and Hornbrook, and considers major past or ongoing projects that have impacted, or currently impact, population and housing resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of population and housing resource area effects (Section 3.16). Non-project activity types within the population and housing Area of Analysis with the potential for significant cumulative population and housing impacts are included in Table 3.24-1.

The nature of the above-listed projects is that they could increase population growth and create housing demand, especially during construction periods when additional workers would be present.

Significance criteria for cumulative aquatic resources impacts are the same as defined in Section 3.16.3 *[Population and Housing] Significance Criteria*.

Potential Cumulative Impact 3.24-54 Short-term and long-term population and housing effects from the Proposed Project in combination with residential and industrial development projects.
The potential effects of the Proposed Project on unplanned population growth would be limited to the temporary influx of workers required for dam removal construction activities and would have no significant impact (Potential Impact 3.16-1). Similarly, the potential effects of the Proposed Project on the displacement of people or housing is limited to the need for an additional temporary worker population during construction activities, and their potential housing needs, and there would be no significant impact (Potential Impact 3.16-2). No large-scale residential development projects have been identified within the vicinity of the Proposed Project. It is possible that other construction projects would attract workers to the area at a similar time, such as the Sousa Ready Mix Concrete Batch Plant Project in Yreka, development of Siskiyou County jail in Yreka, a nanocellulose facility development in Yreka, as well as restoration projects, road repair and construction, mining, and telecommunications projects (Table 3.24-1). The combined impact of the Proposed Project and these other reasonably foreseeable future projects that could attract workers to the area would be a less than significant impact with respect to unplanned population growth or the need for replacement housing at the

County-wide level due to the large (>4,000) number of vacant units available for use (Potential Impact 3.16-1). Within the City of Yreka, the cumulative impact on unplanned population growth or the need for replacement housing has potential to be significant and adverse if other development projects occur concurrently with the Proposed Project and a substantial number of workers from outside of Yreka converge on the city. However, given that the temporary population increase due to the Proposed Project would be small (0.4 percent) (Potential Impact 3.16-2), and most workers for the Proposed Project are anticipated to be sourced from Yreka and smaller nearby communities, the Proposed Project's use of vacant units would be minimal, and the incremental impact on population and housing would not be cumulatively considerable.

Significance

No significant cumulative impact at the County-wide level

Not cumulatively considerable for the City of Yreka

3.24.17 Public Services

The Area of Analysis for public services includes the immediate vicinity of Copco No. 1, Copco No. 2, and Iron Gate dams, including their associated reservoirs, and areas identified as construction/demolition and staging areas. The Area of Analysis for public services also includes communities in the immediate vicinity of the Proposed Project, lands managed for public use by the USDA Forest Service and the BLM, and routes utilized for providing public services. Recreation, roads, fire hazards, and energy production are discussed in this section only in terms of their relationship to analysis of public services.

Existing conditions for public services are described in Section 3.17.2 *[Public Services] Environmental Setting,* which describes fire protection, police, medical services, schools, parks, and other public facilities within the Area of Analysis. Fire protection in the Area of Analysis is provided via cooperative fire protection agreement with CALFIRE. Police services are provided by The Siskiyou County Sheriff's Department and the California Highway Patrol. There are no medical services provided directly within the Area of Analysis. The nearest medical facilities are located in Klamath Falls, OR, Ashland, OR, Dorris, CA, and Yreka, CA. Dispatch services for emergencies are provided by the Yreka Communications Center. Bogus Elementary School is the closest school to the public services Area of Analysis. It is located 5.3 miles from Copco No. 1 Reservoir. As described in Section 3.20 *Recreation,* the Area of Analysis contains a number of recreational facilities, including the reservoirs associated with the Lower Klamath Project. Section 3.17.2 *[Public Services Effects] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, public services.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of public services resource area effects (Section 3.17). Non-project activity types within the Area of Analysis with the potential for significant cumulative effects were considered in relation to the potential project impact types evaluated in Section 3.17.5 *[Public Services] Potential Impacts and Mitigation*, including:

- Construction and demolition activities that could increase response times or increase the need for police and medical services;
- Increased risk of wildfires and the need for firefighting measures or resources;
- Changes in long-term water source availability for wildfire fighting; and
- Potential effects to parks and other public facilities.

Potential Cumulative Impact 3.24-55 Short-term and long-term public services effects from the Proposed Project in combination with non-project activities. The Proposed Project could result in a significant short-term impact if it resulted in substantial increased emergency response times within the Area of Analysis. Other projects and activities that could potentially impact emergency response times include multiple thinning and forest fuel reduction projects in the Happy Camp, Oak Knoll, Salmon River, Scott River, and Goosenest Ranger Districts of the Klamath National Forest, the Brooks Mine, fiber optic cable installation along Highway 96, PacifiCorp powerline replacement in the Happy Camp Ranger District, Guys Gulch Road Realignment, Wooley Creek Bridge Rehabilitation, KHSA (IM)-16 Water Diversion Projects, and construction of the Yreka Nanocellulose Facility, Siskiyou County Jail, Rain Rock Casino, Sousa Ready Mix Concrete Batch Plant, and the Fruit Growers Supply Company Sawmill (Table 3.24-1). These projects are unlikely to overlap in space and time with the Proposed Project's potential impacts to public services response times or emergency service routes, with the exception of KHSA (IM)-16 Water Diversion Projects and the Yreka Nanocellulose Facility, Siskiyou County Jail, Rain Rock Casino, Sousa Ready Mix Concrete Batch Plant, and Fruit Growers Supply Company Sawmill projects. If these projects occur at the same time as the Proposed Project, they could add to the increased emergency response times from the Proposed Project described as Potential Impact 3.17-1. Although the Emergency Response Plan, Fire Management Plan, Traffic Management Plan (TMP), and Hazardous Materials Management Plan to be prepared per Mitigation Measures HZ-1 and Recommended Measure TR-1 would take into account any other construction projects occurring at the same time that could potentially slow emergency services access in the affected area, the State Water Board cannot ensure the TMP's and Emergency Response Plan's implementation. As with Potential Cumulative Impact 3.24-65, the combination of the Proposed Project, measures HZ-1 and TR-1, and one or more other construction projects within the Area of Analysis would be unlikely to result in significant impacts to traffic and transportation. However, because the State Water Board has determined that short-term construction-related impacts of the Proposed Project would be significant and unavoidable with respect to traffic flow, road safety, road conditions, emergency access, public transit, and non-motorized transportation, unless and until KRRC reaches enforceable 'good citizen' agreements through the FERC process, it has determined the incremental contribution of the Proposed Project in this Draft EIR to be cumulatively considerable.

The Proposed Project could result in effects to public services via environmental incidents and accidents that could add additional burden to fire protection, police, medical services, schools, parks, and other public facilities (Potential Impact 3.17-1). The Campora Propane project in Yreka and Pacific Connector Gas Pipeline in Oregon (Table 3.24-1) are in development and may present such risks, but are a substantial distance from the Proposed Project, such that they are not expected to cause significant impacts in the Area of Analysis in the unlikely event that an environmental incident or accident occurred. Additionally, the Pacific Connector Gas Pipeline would be not be transporting gas in liquified form. Therefore, the cumulative impact would not be significant.

The Proposed Project could expose people or structures to a risk of loss, injury, or death involving wildland fires by reducing reservoir storage (Potential Impact 3.17-2, and Potential Cumulative Impact 3.21-8). 2017 court-ordered flushing and emergency dilution flows could change flows from upstream of the Proposed Project and affect the volume of water available for firefighting in the Area of Analysis, and the timing of the 2017 flows is likely to have a beneficial effect during wildfire season. Although changes to flow management may occur in the future, no other projects identified in Table 3.24-1 would reduce reservoir water storage. USDA Forest Service wildfire fuel reduction projects on National Forest land such as the Six Shooter Project are intended to reduce the risk of catastrophic fire. Therefore, the cumulative impact is not significant.

No project or non-project activity types within the area of analysis that could potentially effect school services and facilities (Potential Impact 3.17-3) overlap in type, location, or time with anticipated Proposed Project impacts; therefore, there would be no cumulative impact to public services related to school services and facilities.

Significance

Cumulatively considerable in the short term

No significant cumulative impact in the long term

3.24.18 Utilities and Service Systems

The Area of Analysis for utilities and service systems consists of lands within the Project Boundary (Figure 2.2-4), plus consideration of disposal capacities for accommodating solid wastes at the Yreka Transfer facility near Hornbrook, CA, the Class 1 Landfill near Anderson, CA, and the Dry Creek landfill site in White City, OR. These areas could potentially experience utility and service effects from the Proposed Project. Potential cumulative impacts to wastewater and stormwater would be limited to lands within he Project Boundary. Potential cumulative impacts of short-term waste export are also addressed in Section 3.24.21 *[Cumulative Effects] Hazards and Hazardous Materials* and Section 3.24.22 *[Cumulative Effects] Transportation and Traffic.* Potential cumulative impacts to water supply are addressed in Section 3.24.8 *Cumulative Effects [Water Supply/Water Rights].*

Existing conditions for wastewater, stormwater, and solid waste systems are described in Section 3.18.2 *[Utilities and Service Systems] Environmental Setting*.
The City of Yreka's wastewater treatment plant treats domestic and industrial sewage generated within the city's boundaries (City of Yreka 2017). Communities in unincorporated Siskiyou County either operate community wastewater treatment systems, on-site septic systems, or use an adjacent city's wastewater treatment facilities (USBR 2012). Recreational facilities located along the shoreline of Project reservoirs have vault toilets. No municipal stormwater systems are located within the Area of Analysis for utilities and service systems. Stormwater captured by impervious surfaces at existing Project facilities and within Hornbrook and Copco Village is conveyed by and to natural drainages (FERC 2004).

The Area of Analysis is not served by any water district. Water supplies are provided to rural residences near the Lower Klamath Project facilities by private wells (USBR 2012). The Proposed Project site is within the jurisdictional boundaries of the Siskiyou County Integrated Solid Waste Management Regional Agency, which operates five solid waste recycling and transfer sites (CalRecycle 2017a, Siskiyou County 2017b). Section 3.18.2 *[Utilities and Service Systems] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, utilities and service systems.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of utilities and service systems resource area effects (Section 3.18). The following project types were considered:

- Large-scale construction projects;
- Large-scale demolition projects;
- Industrial development projects;
- Community development projects; and
- Large-scale residential subdivisions.

Potential Cumulative Impact 3.24-56 Short-term and long-term utilities and service system effects from the Proposed Project in combination with non-project activities.

The Proposed Project proposes to dispose of solid waste at the County transfer station located at the former landfill site on Oberlin Road, two miles southeast of Yreka, California, which is the nearest transfer station that could be used for recycling and waste disposal/transfer during dam demolition. The transfer station is permitted to accept general residential, commercial, and industrial refuse for disposal. The Yreka Transfer Facility has a capacity of 100 tons per day. Currently, solid waste is transferred to the Dry Creek Landfill near White City Oregon. In 2018, this landfill had a total capacity of 76,800,000 tons with a life projected at over 100 years (Dry Creek Landfill, 2018).

Hazardous materials must be disposed at certified Class I landfill facilities, which are lined to prevent the contamination of underlying soils and groundwater. The Anderson Landfill in Anderson, California, is located 122 miles south of Hornbrook, California, and is permitted to accept hazardous waste. The Anderson Landfill had an estimated remaining capacity of 11,914,025 cubic yards (72 percent of capacity remaining) in 2008, with an anticipated closure date of 2055 (CalRecycle 2017a). Estimated quantities of solid waste from the Proposed Project are described in Section 2.7.1 *Dam and Powerhouse Deconstruction*, as well as in the Definite Plan (Appendix B: *Definite Plan – Tables 5.3-3, 5.4-3* and *5.5-3*). Solid waste volumes from the Proposed Project would be within the limitations noted above (Potential Impacts 3.18-3 and 3.18-4). The expansion of the Kidder Creek Orchard Camp, the opening of the Siskiyou County Jail, Trinity County Jail, and Rain Rock Casino, and the potential demolition of the Ringe Pool Facility (Table 3.24-1) have the potential to increase solid waste contributions to regional landfills. The landfills described above are expected to have the capacity to accept solid waste from these projects as well as from the Proposed Project.

The Proposed Project would not have significant impacts associated with the construction of new wastewater and/or stormwater treatment facilities, or expansion of existing facilities (Potential Impacts 3.18-1 and 3.18-2). Large non-project construction activities would be required to obtain coverage individually under the Statewide Construction General Permit (CGP), requiring applicants to address erosion and sediment control, stormwater, spill prevention and containment, and site cleanup. No non-project activity types within the Area of Analysis that could potentially effect wastewater or stormwater would overlap in type, location, or time with anticipated impacts due to the Proposed Project; therefore, there would be no significant cumulative impact associated with wastewater or stormwater services.

As the Proposed Project would not have a significant adverse impact on utilities and service systems, and there are no closely related projects that would, in combination with the Proposed Project, have a significant and adverse impact, there would be no significant cumulative utilities and service systems impacts.

Significance

No significant cumulative impact

3.24.19 Aesthetics

The Area of Analysis for aesthetics is the Klamath River from the Oregon-California state line to the Klamath River Estuary. The Primary Area of Analysis for aesthetics is within the viewshed of the Lower Klamath Project reservoirs, which includes the proposed Limits of Work in California (i.e., Copco No. 1, Copco No. 2, and Iron Gate dams, reservoirs, and associated facilities, and the areas identified as construction/demolition areas and staging areas), plus a buffer to the ridgeline of surrounding the reservoirs (Figure 3.19-1).

Existing conditions for aesthetics are defined in Section 3.19.2 *[Aesthetics] Environmental Setting*. The Area of Analysis for aesthetic resources contains BLM VRM Class III visual resources, for which the objective is to retain the existing character of the landscape, with only moderate change from a project such as the Proposed Project. The variety of color, vegetation, landforms, adjacent scenery, scarcity, cultural modifications, and the presence of water within the Area of Analysis leads to a BLM Class A (distinctive inherent scenic attractiveness) classification for scenic quality. The Area of Analysis also has a High BLM visual sensitivity classification, meaning the public seeks a high level of visual quality in the landscape, and a foreground-middleground distance zone classification. Additionally, Klamath River components are part of the National (and state) Wild and Scenic Rivers (WSR) System, because of their free-flowing condition and “outstandingly remarkable” values. The “State of Jefferson” National Forest Scenic Byway, and “Bigfoot” National Forest Scenic Byway are also situated within the Area of Analysis. Section 3.19.2 *[Aesthetics] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, aesthetics resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of utilities and service systems resource area effects (Section 3.18).

This cumulative impact analysis focuses on the impact of the Proposed Project and other projects that are not already considered in the analysis of aesthetics resource area effects (Section 3.19) due to actions and elements included in the Proposed Project (Section 2). Non-project activity types within the aesthetics Area of Analysis with the potential for significant cumulative land use and planning impacts include (Table 3.24-1):

- Large-scale construction projects;
- 2017 court-ordered flushing and emergency dilution flows, or other hydrological impacts that change flow characteristics, open water conditions, channel morphology, or turbidity;
- Water discharges that visually affect water quality;
- Riverine restoration projects;
- Changes or removal of historic structures;
- Near-channel infrastructure projects (i.e., bridges, culverts); and
- Large-scale infrastructure projects.

Significance criteria for cumulative aquatic resources impacts are the same as defined in Section 3.19.3 *[Aesthetics] Significance Criteria*.

Potential Cumulative Impact 3.24-57 Short-term and long-term scenic vista effects from the loss of open water from the Proposed Project in combination with other non-project activities.

The Proposed Project would have no significant impact from the loss of open water vistas, because open water and lake vistas would be altered in favor of more natural river, canyon, and valley vistas, there are numerous open-water lakes in the region, and visual quality for the public would not be substantially degraded (Potential Impact 3.19-1). No other projects that would result in loss of open water have been identified (Table 3.24-1), thus there would be no significant cumulative impacts to scenic vistas due to the Proposed Project and other closely related projects.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-58 Short-term and long-term scenic resources effects from the Proposed Project in combination with restoration, flow enhancement, and water quality improvement projects, and other non-project activities.

The Proposed Project could affect flow characteristics within sections of Klamath River classified as WSR. Potential changes to flow characteristics include the timing, duration, and magnitude of flows, which can affect channel morphology; however, the Proposed Project would have flow characteristics that are visually similar to existing conditions and visual impacts related to changes of river channel morphology would not be significant (Potential Impact 3.19-2). Other projects (Table 3.24-1) have the potential to alter river channel morphology and result in a cumulative impact. Potential Impact 3.24-1 in Section 3.24.2 *Cumulative Water Quality Effects* provides background and context regarding agency re-consultation on the 2013 BiOp, and Potential Impact 3.24-24 provides a summation of the approach taken in this document. As for Potential Impact 3.24-24, the 2017 court-ordered flushing flows are the focus of this analysis. Surface and deep flushing flows would reflect a more natural regime, thus could have either no impact or beneficial effects to river channel morphology in combination with the Proposed Project.

The Proposed Project would result in significant and unavoidable short-term changes in water quality due to elevated suspended sediment concentrations during reservoir drawdown (Potential Impact 3.2-3); however, the visual quality (water clarity) impact from this would not be a significant impact as the contrast is expected to be weak to moderate (i.e., not a visually noticeable change from existing conditions for most of the drawdown period) and spatially limited (decreasing downstream) (Potential Impact 3.19-3). While there may be an increase in the duration of elevated suspended sediment concentrations in water years when the Proposed Project reservoir drawdown flows do not meet the surface and/or deep flushing flow requirements and the 2017 court-ordered flushing flows are still required to occur until either April 30 (surface flushing flows) or May 31 (deep flushing flows) (see Potential Cumulative Impact 3.25-1 for more details); reduced clarity conditions would be of short duration (i.e., 24 to 72 hours) and spatially limited. Overall, there would not be a short-term cumulative visual quality impact due to the Proposed Project and the 2017 court-ordered flushing flows.

In the long term, the beneficial reductions of seasonal nuisance algae blooms would have no impact on aesthetics (Potential Impact 3.18-3). The 2017 court-ordered flushing flows would improve management of *C. Shasta,* which could have adverse visual water quality outcomes if left uncontrolled. Similarly, other restoration projects occurring within the Klamath Watershed, such as the Long-Term Plan to Protect Adult Salmon in the Lower Klamath River, would reduce nutrients and thus the prevalence of seasonal algae blooms (Table 3.24-1). The Proposed Project, in combination with riverine restoration projects, would have beneficial effects on visual water quality.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-59 Short-term and long-term visual character and quality effects from the Proposed Project in combination with other ground disturbing and construction activities.

The Proposed Project would potentially impact the visual character and quality of the site and its surroundings. Substantial areas of bare sediment and rock would be exposed in previously inundated areas after reservoir drawdown and dam removal, and would remain exposed until vegetation establishes, which would result in a significant impact in the short term (Potential Impact 3.19-4). Existing wetland vegetation on the reservoir shorelines may also die. Other closely related activities that could cause a similar change in visual character within the Lower Klamath Project reservoir footprints include mining and near-channel infrastructure. However, no reasonably foreseeable projects involving such activities within the reservoir footprints have been identified (Table 3.24-1); therefore, there would be no cumulative impact.

Replacement of the Yreka water supply pipeline, bridges, culverts, roads, and recreational facilities would result in minor visual changes compared to existing conditions, which would not constitute a significant short-term or long-term impact (Potential Impacts 3.19-5 and 3.19-6). Although there are other projects of this nature within the Klamath Basin, none of them are within the aesthetics Area of Analysis; therefore, the combination of the Proposed Project and other construction-related projects would not result in a significant cumulative visual impact.

The Proposed Project involves the removal of historic structures (Copco No. 1 Hydroelectric Powerhouse and Dam; Copco No. 2 Hydroelectric Powerhouse; and Copco No. 2 Wooden Stave Penstock) (Potential Impact 3.19-5). Separate from the Proposed Project, no other historic structures have recently been removed, or are known to be planned for removal, in the aesthetics Area of Analysis (Table 3.24-1). Thus, there would be no significant cumulative scenic historic resource impact resulting from the Proposed Project and other closely related projects.

Additionally, there would be potential short-term impacts to visual character and quality due to Proposed Project construction activities, including the presence of vehicles and equipment, temporary structures, temporary access roads, equipment storage, stockpiles, and demolition. The Proposed Project would have temporary weak to strong visual contrasts associated with construction activities and would generate dust, but most nearby recreational facilities with views of the construction site would be closed for the duration of the construction period, thus the impact would not be significant (Potential Impact 3.19-6). Although it is possible that there would be small-scale construction activities within the Area of Analysis at the same time as the Proposed Project, no overlapping large-scale construction projects are anticipated that would, in combination with the Proposed Project, result in reasonably foreseeable significant and adverse aesthetics impacts. Thus, there would be no cumulative aesthetics impacts due to the construction activities associated with the Proposed Project.

Significance

No significant cumulative impact

Potential Cumulative Impact 3.24-60 Short-term light and glare effects from the Proposed Project in combination with other construction projects.

Temporary lighting would be erected for nighttime construction activities under the Proposed Project, and security lighting may be required during deconstruction (Potential Impact 3.19-7). Although the Proposed Project would result in significant and unavoidable adverse impacts due to construction-related lighting, there are no closely related, spatially and temporally overlapping projects that would, in combination with the Proposed Project, result in further significant and adverse light or glare impacts (Table 3.24-1). Thus, there would be no significant cumulative aesthetics impacts due to short-term lighting and glare under the Proposed Project.

Significance

No significant cumulative impact

3.24.20 Recreation

The Area of Analysis for recreation includes recreation areas and associated access along the Klamath River corridor from the California-Oregon border to the Klamath River Estuary (Figure 3.20-1).

Existing conditions for recreation are defined in Section 3.20.2 *[Recreation] Environmental Setting*. Within the Klamath Basin, there are four national forests (Klamath, Fremont – Winema, Six Rivers, and Modoc), one joint national and state park (Redwood), one national park (Crater Lake), two national monuments (Lava Beds and Cascade – Siskiyou), and five National Wildlife Refuges (NWRs) (Klamath Marsh, Tule

Lake, Clear Lake, Upper Klamath, and Lower Klamath). These areas provide sightseeing, camping, hiking, fishing, wildlife viewing, and other recreational opportunities. Within the Klamath Basin, the Klamath, Scott, Salmon, Sprague, Sycan, Smith, and Trinity rivers, and Wooley Creek have segments classified as having Wild and Scenic values under the WSRA. Additionally, there are extensive public and private recreational opportunities along the Klamath River and within several lakes/reservoirs. Developed recreational facilities, including: Agency Lake, Upper Klamath Lake, the Link River Trail, and the Keno Impoundment/Lake Ewauna, and activity specific recreational resources, are described in Section 3.30.2 *[Recreation] Environmental Setting*. Section 3.20.2 also includes consideration of major past or ongoing projects that have impacted, or currently impact, recreation resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of recreation resource area effects (Section 3.20). Non-project activity types within the recreation Area of Analysis with the potential for significant cumulative recreational impacts include (see also Table 3.24-1):

- Development projects, especially large-scale construction;
- Restoration, flow enhancement, and water quality improvement projects ; and
- Water flow changes and whitewater boating.

Significance criteria for cumulative aquatic resources impacts are the same as defined in Section 3.20.3 *[Recreation] Significance Criteria*.

Potential Cumulative Impact 3.24-61 Short-term and long-term recreation effects from the Proposed Project in combination with development projects.
Proposed Project short-term construction-related impacts on existing recreational opportunities would not be significant (Potential Impact 3.20-1) for the following reasons: a number of reservoirs, lakes, and rivers are present within and adjacent to the Klamath Basin that provide similar recreational opportunities as areas where access would be restricted during Proposed Project construction; several existing recreational sites are located away from where dust and noise would be generated during Proposed Project construction; turbidity impacts would be short-term and primarily during the winter when recreational use for non-contact (e.g., boating) and contact recreation (e.g., swimming and fishing) is relatively low; and water quality and clarity would improve with distance downstream of Iron Gate Dam, as sediments are flushed downstream and into the Pacific Ocean. Although there is potential for other large-scale construction projects in the Klamath Basin to temporally overlap with the Proposed Project, such as the Sousa Ready Mix Concrete Plant and the potential nanocellulose facility, these projects would be located in Yreka (Table 3.24-1). Such projects in Yreka are not close enough to the Proposed Project reservoir footprints and/or the Middle Klamath River immediately downstream of Iron Gate Dam (where turbidity impacts would be greatest) to result in a significant cumulative impact. There may be some overlapping, small-scale construction projects in more proximal locations (Table 3.24-1), but there are no other reasonably foreseeable construction projects that would contribute to a short-term adverse cumulative impact on recreation in the area where the Copco No. 1, Copco No. 2, and Iron Gate dams are proposed for removal (Table 3.24-1). Thus, the Proposed Project, in combination with other construction projects, would not have a significant adverse cumulative impact on recreational opportunities in the Area of Analysis.

The Proposed Project would not have significant long-term impacts on reservoir-based recreation activities (Potential Impact 3.20-2), or substantial or accelerated physical deterioration of other regional facilities (Potential Impact 3.20-3). Under the Proposed Project, Fourmile Lake, Agency Lake, Applegate Reservoir, and Medicine Lake would all continue to provide region-wide open-water activities, some reservoir facilities would remain, and would be upgraded or enhanced where possible, and most existing river access would be retained and upgraded. Steelhead, trout, and salmon fisheries in the Klamath River would be enhanced. Any loss of warm water fishing opportunities is not over a large area and there are other warm water fishing opportunities elsewhere in California and Oregon. No other reasonably foreseeable development projects have been identified in the Area of Analysis for recreation that would remove reservoirs, adversely impact recreational opportunities in other lakes and reservoirs, or reduce warm water fishing opportunities. In the absence of spatially and temporally overlapping development projects, there would be no significant cumulative impacts to reservoir-based recreation or physical deterioration of regional facilities.

Significance
No significant cumulative impact

Potential Cumulative Impact 3.24-62 Short-term and long-term recreation effects from the Proposed Project in combination with other restoration, flow enhancement, and water quality improvement projects.
The Proposed Project would improve scenery, recreation, fisheries, and wildlife values (which are values specified in the Wild and Scenic River Act Section 7(a)) on the California Klamath Wild and Scenic River segments (both designated and eligible for listing) (Potential Impact 3.20-7). Other aquatic habitat restoration, flow enhancement, and water quality improvement projects along the Klamath River and its tributaries (see Table 3.24-1) would include placement of off-channel habitat features, floodplain restoration, incorporation of large wood into tributaries to the Klamath River, increases in stream flow, and reduction in water quality pollutants. These types of projects would have a beneficial cumulative effect on recreation associated with wild and scenic values in the long term.

The Proposed Project would be beneficial with respect to the river-based recreational fishing because it would: restore volitional fish passage, improve long-term water quality, likely increase recreational fish species, and implement the Recreation Facilities Plan for the Hydroelectric Reach (Potential Impact 3.20-6). There would be no significant impact to, or loss of, other river-based recreation, for the Middle Klamath River between Iron Gate Dam and Humbug Creek under the Proposed Project, because there is only one structure that is expected to be within the post-dam removal 100-year floodplain that is not in the floodplain under existing conditions (Potential Impact 3.20-6). Other restoration projects (Table 3.24-1) would also improve fisheries by restoring habitat; therefore, the Proposed Project in combination with other restoration projects would be beneficial for recreational fishing.

Significance
Beneficial cumulative effects

Potential Cumulative Impact 3.24-63 Short-term and long-term whitewater boating effects from the combination of the Proposed Project and water flow changes.

The Proposed Project would result in a significant adverse impact due to reduction of whitewater boating opportunities in the Hell's Corner river reach (in the upper portion of the Hydroelectric Reach) (Potential Impact 3.20-5). However, with the Proposed Project there would also be an increase in whitewater boating opportunities in the Copco No. 2 Bypass Reach, and there could be improvements in the quality and quantity of whitewater boating opportunities in areas currently inundated by reservoirs. There are no closely related projects (Table 3.24-1) that would, in combination with the Proposed Project, result in further significant and adverse whitewater boating impacts in the Hell's Corner river reach or other reaches of the Klamath River or its tributaries. The 2017 court-ordered flushing flows (interim flows until re-consultation of the 2013 BiOp is completed, see also Potential Cumulative Impact 3.24-1) would increase water flows during relatively short (i.e., 24 to 72 hours) controlled periods (see Potential Cumulative Impact 3.24-1), which could provide periodic benefits to whitewater boaters. No projects have been identified that would substantially reduce flows and result in a significant cumulative impact on whitewater boating opportunities in combination with the Proposed Project (Table 3.24-1).

Significance
No significant cumulative impact

3.24.21 Hazards and Hazardous Materials

The Area of Analysis for hazards and hazardous materials includes the area in the immediate vicinity of Copco No. 1, Copco No. 2, and Iron Gate dams and reservoirs, and areas identified as construction/demolition and staging areas. The Area of Analysis for hazards and hazardous materials also includes routes proposed to be utilized for the transportation of construction debris and equipment.

Existing conditions for hazards and hazardous materials are described in Section 3.21.2 *[Hazards and Hazardous Substances] Environmental Setting*, which describes transport/releases of hazardous materials, school proximity, contaminants/contaminated sites, nearby airports, emergency response, and wildfires. Section 3.21.2 *[Hazards and Hazardous Substances] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, environmental resources. This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of hazards and hazardous substances resource area effects (Section 3.21). Non-project activity types within the hazards and hazardous materials Area of Analysis with the potential for significant cumulative impacts include (see also Table 3.24-1):

- Construction or demolition projects involving the transport, use, disposal of emissions, or accidental release of hazardous materials;
- Land use or land management changes involving the transport, use, disposal of emissions, or accidental release of hazardous materials;
- Projects or plans that could impair implementation emergency response or emergency evacuation plans;
- 2017 court-ordered flushing and emergency dilution flows;
- Wildfires; and
- Forest and wildfire management.

Potential Cumulative Impact 3.24-64 Short-term and long-term hazards and hazardous materials effects from the Proposed Project in combination with non-project activities.

No non-project activity types within the hazards and hazardous materials Area of Analysis that could be located on a hazardous materials site, projects that could result in a safety hazard within two miles of airports, or that could impair implementation emergency response or emergency evacuation plans (Potential Impacts 3.21-5, 3.21-6, and 3.21-7), would have the potential for significant incremental short- or long-term cumulative impacts related to hazards and hazardous substances because none of these activities would overlap in type, location, or time with anticipated impacts under the Proposed Project.

The Proposed Project could result in substantial exposure for the public or environment to hazards or hazardous materials due to routine transport, use, or disposal of hazardous materials, potential accidental release of hazardous materials, or be located on a hazardous site (Potential Impacts 3.21-1, 3.21-2, and 3.21-3), and would require implementation of Mitigation Measure HZ-1 to reduce potential impacts to less than significant. Although the Campora Propane and Pacific Connector Gas Pipeline projects are in development and may present similar risks, both projects are too distant from the Lower Klamath Project dam complexes in California to cause significant impacts in the Area of Analysis. Thus, there would be no cumulative impact.

The Proposed Project would result in a significant and unavoidable long-term impact due to reduction in reservoir storage for fighting wildland fires (Potential Impact 3.21-8) because the State Water Board cannot ensure the implementation of Recommended Measure PS-1, which would require a Fire Management Plan after reaching agreement with CALFIRE on a long-term water source replacement for helicopter and ground crews (including construction and utilization of proposed dry hydrants, dip ponds or other alternatives). While the effects of new BiOp flow requirements for the Klamath Irrigation Project are speculative, the 2017 flow requirements (i.e., 2013 BiOp Flows plus the 2017 court-ordered flushing and emergency dilution flows) periodically increase the volume of water entering the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam by requiring 24-hr to 72-hr periods of higher flows into May and June. While this short period of inflow and limited periodicity is not sufficient to be beneficial with respect to fighting wildland fires, the 2017 flow requirements would not reduce the volume of water available for firefighting during the spring and early summer months (see also Potential Cumulative Impact 3.24-1) and there would be no cumulative impact to water supply. Although changes to flow management in the Hydroelectric Reach and the Middle Klamath River may occur in the future, no other reasonably foreseeable projects identified in Table 3.24-1 would reduce flows or water storage in the Hydroelectric Reach. Further, wildfire fuel reduction projects, including the USDA Forest Service projects on National Forest lands (e.g., Six Shooter Project) and firefighting are intended to reduce the risk of catastrophic fire. Therefore, the cumulative effects of the Proposed Project, when combined with the USDA Forest Service or any other wildfire fuel reduction projects, would not be significant in regard to wildfire ignition risk. As discussed above (Potential Cumulative Impact 3.24-25), wildfire itself is a potential hazard, and may occur in Area of Analysis in the future. If a large fire occurs in the Area of Analysis during the construction period for the Proposed Project, work would be suspended due to health and safety reasons (see Potential Cumulative Impact 3.24-34 [Air Quality]); therefore, temporal overlap is unlikely.

Significance
No significant cumulative impact for hazardous materials

Cumulatively considerable for firefighting water access

3.24.22 Transportation and Traffic

The Area of Analysis for cumulative transportation and traffic effects encompasses roadways in Siskiyou and Shasta Counties that would be used by construction vehicles and workers and could potentially be affected by the Proposed Project. Table 3.22-1 lists the regional and local roads that access each California site of the Proposed Project (Copco No. 1, Copco No. 2, and Iron Gate dams). These roads include Copco Road, Ager-Beswick Road, Lakeview Road, and California segments of I-5. Equipment hauling and waste disposal for J.C. Boyle Dam would occur only in Oregon (Appendix B: *Definite Plan*).

Existing conditions for transportation resources are described in Section 3.22.2 [*Transportation*] *Environmental Setting*. Roadways in Siskiyou County are generally rural. Most of the private property in the area is undeveloped and/or used as grazing land for cattle, with the exception of several small communities in the vicinity of Copco No. 1 and Iron Gate reservoirs. With the exception of Interstate 5, roads in the Area of Analysis are one- or two-lane collector or local rural roads. Level of Service (LOS) conditions on Interstate 5 are currently at LOS A, which indicates free flow of traffic. The major access roadways in the Area of Analysis that are likely to be affected by Proposed Project-related traffic are also currently at LOS A (Greendot 2016). Surveys conducted in 2017 identified several roadways, bridges and culverts that are not structurally competent to withstand construction-related traffic. Section 3.22.2 *[Transportation and Traffic Effects] Environmental Setting* includes consideration of major past or ongoing projects that have impacted, or currently impact, transportation and traffic resources.

This cumulative impact analysis focuses on the potential impacts of the Proposed Project combined with other closely related projects that are not already considered in the analysis of transportation and traffic resource area effects (Section 3.22). Non-project activity types within the Area of Analysis with the potential for significant cumulative effects when combined with the Proposed Project were considered in relation to the potential impact types evaluated in Section 3.22.5 *[Transportation and Traffic] Potential Impacts and Mitigation*. These include activities that could create potential impacts to traffic flow, road safety, road conditions, emergency access, public transit, and non-motorized transportation by either temporarily increasing traffic volume or impeding traffic flow. The non-project activity types (plus wildfires) include the following (see also Table 3.24-1):

- Forest and wildfire management;
- Construction projects;
- Restoration projects; and
- Road repair.

Potential Cumulative Impact 3.24-65 Short-term and long-term traffic and transportation effects from the Proposed Project in combination with non-project activities.

As described in Section 3.22.5 *[Transportation and Traffic] Potential Impacts and Mitigation*, the Proposed Project would result in significant and unavoidable short-term impacts to traffic flow, road safety, road conditions, emergency access, public transit, and non-motorized transportation, unless and until KRRC reaches enforceable 'good citizen' agreements that are finalized and implemented through the FERC process and that include proposed items for the final TMP and Emergency Response Plan (Appendix B: *Definite Plan − Appendices O1 through O4*), as well as the additional components included in Recommended Measure TR-1 (Potential Impacts 3.22-1 through 3.22-5).

The Proposed Project is not located within two miles of an airport nor would it result in a change in air traffic patterns that would result in a substantial safety risks (Potential Impact 3.22-6). Therefore, there would be no cumulative impacts related to air traffic due to the Proposed Project in combination with non-project activities within the traffic and transportation Area of Analysis.

It is possible that some riverine restoration projects, such as projects under the Klamath Basin Restoration Program, forest and wildfire management projects, and road repair projects, could overlap temporally, but they are unlikely to occur close enough to Proposed Project construction areas to contribute to a cumulative impact. The closest known forest and wildfire management projects are not within the Area of Analysis for transportation and traffic (i.e., Somes Bar Integrated Fire Management Project; approximately 90 miles downstream of Humbug, and Crawford Vegetation Management Project; approximately 70 miles downstream of Humbug) and so would not overlap spatially with the Proposed Project. The Proposed Project includes road, bridge, and improvement projects associated with the primary access roads (Copco Road, Ager-Beswick Road, Lakeview Road), so other road repair projects occurring at the same time as the Proposed Project would necessarily be located elsewhere.

Other potential construction projects identified in Table 3.24-1 (e.g., Sousa Ready Mix Concrete Batch Plant Project, Siskiyou County jail development, and a potential nanocellulose facility development) are all located in Yreka, and as such, would not be likely to require use of the primary access roads associated with the Proposed Project (Copco Road, Ager-Beswick Road, Lakeview Road) for which short-term impacts to traffic flow, road safety, road conditions, emergency access, public transit, and non-motorized transportation could occur. California segments of Interstate 5, which would be used by workers and for hauling equipment and supplies to and from the Proposed Project, could be used by one or more of the potential other construction projects for the same reasons and during the same time period, although the smaller scale of the other projects would be unlikely to result in a high number of vehicle trips relative to the Proposed Project. Since Interstate 5 has sufficient capacity for added traffic (391 ADT) associated with the Proposed Project to keep the LOS level at LOS A (see Potential Impact 3.22-1), the combination of the Proposed Project and one or more other construction projects within the Area of Analysis would be unlikely to result in significant impacts to traffic and transportation. However, because the State Water Board has determined that short-term construction-related impacts of the Proposed Project would be significant and unavoidable with respect to traffic flow, road safety, road conditions, emergency access, public transit, and non-motorized transportation, unless and until KRRC reaches enforceable 'good citizen' agreements through the FERC process (as described above), it has determined the incremental contribution of the Proposed Project in this Draft EIR to be cumulatively considerable.

Significance
Cumulatively considerable

3.24.23 Noise

The Area of Analysis for noise and vibration consists of areas in the general vicinity of Copco No. 1, Copco No. 2, and Iron Gate reservoirs, and project haul routes in Siskiyou County where there is potential for impacts to sensitive receptors (i.e., residences) from deconstruction, waste transportation, and worker commutes.

Existing conditions for noise are described in Section 3.23.2 *[Noise] Environmental Setting*. Noise-sensitive receptor locations (e.g., rural residences, residences, certain parks) were identified within the Area of Analysis for noise and vibration, based on a review of current topographic, aerial, and land use maps. Existing ambient noise levels were identified for both daytime and nighttime. At each dam work site, the estimated existing daytime and nighttime outdoor L_{eq} (equivalent sound level) at nearby sensitive receptors are 40 and 30 dBA (A-weighted decibels, representing the perception of loudness), respectively (USEPA 1974) (Table 3.23-1; and section 3.23.2.1 for definitions of relevant terms). Existing roadway traffic noise along the proposed haul routes associated with each dam is shown in Table 3.23-2.

The nature of noise impacts is that they are inherently in the present. For there to be a cumulative impact from two or more projects together exceeding acceptable noise volumes, there would need to be temporal overlap with the Proposed Project. Projects that do not have temporal overlap, but occur immediately before or after the Proposed Project, could have a cumulative impact by increasing the duration of elevated noise volumes. Therefore, this analysis considers projects that may overlap in space and time with the Proposed Project, or that may overlap in space and occur immediately before or after the Proposed Project.

This cumulative impact analysis focuses on the potential impacts of the Proposed that are not already considered in the analysis of noise resource area effects (Section 3.23). Other project activity types within the noise Area of Analysis with the potential for significant cumulative noise and vibration impacts include (see also Table 3.24-1):

- Large-scale development;
- Construction for riverine restoration projects;
- Fire management activities, including thinning;
- Mining;
- Use of agricultural vehicles and equipment; and
- Recreational activities involving motors or large crowds.

Significance criteria for noise and vibration impacts are the same as defined in Section 3.23.3 *[Noise] Significance Criteria*.

Potential Cumulative Impact 3.24-66 Short-term noise effects from the Proposed Project in combination with other non-project activities.
The Proposed Project would result in noise and vibration that will affect sensitive receptors and exceed Siskiyou County General Plan standards. Significant and unavoidable adverse environmental impacts would result from: construction equipment

exceeding maximum allowable noise levels (Potential Impact 3.23-1); noise disturbance to residents from construction-generated noise at Copco No. 1 and Iron Gate dams (Potential Impacts 3.23-2 and 3.23-4), reservoir restoration at Copco No.1 and Iron Gate dams (Potential Impact 3.23-5); and vibration disturbance from blasting activities at Copco No. 1, Copco No. 2, and Iron Gate dams (Potential Impact 3.23-6). Other noise and vibration generation from the Proposed Project would not have a significant adverse impact (Section 3.23-5 *[Noise] Potential Impacts and Mitigation*). Upon review of other projects that are anticipated to result in a noise or vibration disturbance (Table 3.24-1), most of these do not overlap in space and time with the Proposed Project. It is possible that some riverine restoration projects, such as projects under the Klamath Basin Restoration Program, and fire management projects, could overlap temporally, but they are unlikely to occur close enough to Proposed Project construction and blasting areas to contribute to a cumulative impact. Ongoing mining, agricultural, and recreational activities could also overlap temporally, but no new projects or activities of this nature have been identified within the vicinity of Copco No. 1, Copco No. 2, and Iron Gate dams; therefore, noise generation from these activities would be part of the existing conditions. Additionally, recreational access to the Lower Klamath Project reservoirs would be limited during blasting and heavy construction periods such that ongoing recreational activities that generate noise would be unlikely to occur within the noise and vibration Area of Analysis. Potential future large-scale development projects identified in Table 3.24-1 (e.g., Sousa Ready Mix Concrete Batch Plant Project, Siskiyou County jail development, and a potential nanocellulose facility development, all in Yreka) are not close enough to the Proposed Project's expected area of noise and vibration generation to result in a significant and adverse combined impact. No other closely related projects that would result in a significant and adverse combined noise impact along Proposed Project haul routes have been identified.

Although the Proposed Project would result in significant and unavoidable adverse impacts due to construction- and restoration-related noise, there are no closely related projects that would, in combination with the Proposed Project, result in further significant and adverse noise and/or vibration impacts. Thus, there would be no significant cumulative noise or vibration impacts due to the Proposed Project and other closely related projects.

Significance

No significant cumulative impact

3.24.24 References

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4 ALTERNATIVES

4.1 Alternatives Selection/Overview

Section 15126.6 of the CEQA Guidelines requires that an EIR describe and evaluate a reasonable range of alternatives to the project, or to the location of the project, which could attain most of the basic project objectives but would avoid or substantially lessen any of the significant environmental effects of the project. The “rule of reason” governing the range of alternatives specifies that an EIR should discuss sufficient alternatives to allow a reasoned choice by the decision makers, but it does not require consideration of all possible alternatives to a project. Alternatives must be “feasible”, meaning that they can be successfully implemented to accomplish the project’s overall purpose and objectives in a reasonable amount of time, taking into account considerations including cost, existing technology, social factors, legal factors, and environmental issues. (CEQA Guidelines, section 15364.) Therefore, “an EIR need not consider an alternative whose effect cannot be reasonably ascertained and whose implementation is remote and speculative.” (CEQA Guidelines, section 15126.6, subdivision (f)(3).) The EIR should include sufficient information about each alternative to allow meaningful evaluation, analysis and comparison.

The underlying project purpose is the timely improvement of water quality related to the Lower Klamath Project within and downstream of the current Hydroelectric Reach and the restoration of anadromous access upstream of Iron Gate Dam (the current barrier to anadromy). In furtherance of this underlying purpose, the State Water Board has identified the following project objectives (see also Section 1 *Introduction*):

In a timely manner:

1. Improve the long-term water quality conditions associated with the Lower Klamath Project in the California reaches of the Klamath River, including water quality impairments due to Microcystis aeruginosa and associated toxins, water temperature, and levels of biostimulatory nutrients.
2. Advance the long-term restoration of the natural fish populations in the Klamath Basin, with particular emphasis on restoring the salmonid fisheries used for subsistence, commerce, tribal cultural purposes, and recreation.
3. Restore volitional anadromous fish passage in the Klamath Basin to viable habitat currently made inaccessible by the Lower Klamath Project dams.
4. Ameliorate conditions underlying high disease rates among Klamath River salmonids.

4.1.1 Alternatives Selection

In determining a reasonable range of alternatives for the EIR, the State Water Board considered a wide range of potential alternatives. These included prior environmental analyses’ alternatives—both accepted and rejected. The potential alternatives also included alternatives and adjustments to previously-analyzed alternatives raised by agencies, the applicant and the general public since release of the Notice of Preparation, as well as alternatives that arose by incorporating new information generated since completion of prior environmental analyses.

The 2007 FERC EIS analyzed five action alternatives: (1) PacifiCorp's Proposal at that time for continued operation; (2) FERC Staff Alternative for continued operation; (3) FERC Staff Alternative with Mandatory Conditions imposed through the licensing process by other federal agencies; (4) Retirement of Copco No. 1 and Iron Gate Developments; and (5) Retirement of J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Developments. The 2007 FERC EIS considered, but decided not to move forward with, analysis of federal take-over of the dams and cessation of power generation at the facilities, but not requiring removal of the dam facilities themselves.

The 2012 KHSA EIS/EIR analyzed four action alternatives: (1) Dam Removal of Four Dams; (2) Partial Removal of Four Dams; (3) Fish Passage at Four Dams; and (4) Removal of Copco 1 and Iron Gate with Fish Passage at Copco 2 and J.C. Boyle. These were selected from the 17 action alternatives and the No Action/No Project Alternative in the initial alternatives screening process. The 13 rejected action alternatives were: (a) Three Dam Removal; (b) Sequenced Removal of Four Dams; (c) Full Facilities Removal of Four Dams without KBRA; (d) Trap and Haul; (e) Bogus Creek Bypass; (f) Bogus Creek Bypass – Alternative Tunnel Route; (g) Notching Four Dams; (h) Federal Takeover of Project; (i) Full Removal of Five Dams; (j) Full Removal of Six Dams; (k) Dredge Upper Klamath Lake; (l) Predator Control; and (m) Partition Upper Klamath Lake.

The State Water Board revisited the aforementioned listed alternatives, as well as three additional potential alternatives raised in Lower Klamath Project scoping (see also Appendix A). First, Siskiyou County and others proposed examining a fish passage alternative that looks at a combination of trap and haul, fish cannons (a new technology since 2012), and other mechanisms for fish passage without dam removal. The Siskiyou County proposal combines elements of other Lower Klamath Project scoping comments regarding methods of fish passage with dams in place. Second, Siskiyou County and Siskiyou Water Users Association scoping comments also suggested developing an alternative of additional water storage in the Scott and Quartz valleys to augment late summer and fall instream flows. Third, Siskiyou County and Siskiyou County Water Users Association scoping comments also suggested transferring 60,000 acre-feet of water from Iron Gate Reservoir (or J.C. Boyle Reservoir or Keno Reservoir) to the Shasta River sub-watershed as irrigation supply to allow Lake Shastina discharges to go directly into the Shasta River rather than being used as irrigation supply first.

From this initial pool of 24 alternatives, the State Water Board selected five feasible action alternatives that would reduce one or more potentially significant impacts of the Proposed Project and would meet the underlying purpose of the Proposed Project and most of the Proposed Project objectives. Consistent with CEQA Guidelines section 15126.6(e)(2), the State Water Board also included the No Project Alternative in the set of alternatives considered in this EIR. The six alternatives to the Proposed Project that were carried forward for more detailed analysis are introduced briefly in Section 4.1.1.1 and revisited in Sections 4.2 to 4.6 in comparison to existing conditions and the Proposed Project (CEQA Guidelines section 15126.6(d)). Alternatives that were eliminated from consideration because they would not meet the underlying purpose of the Proposed Project or most of the Proposed Project objectives, were substantially similar to other alternatives, would not avoid or substantially lessen significant environmental effects of the Proposed Project, or were otherwise infeasible, are discussed in Sections 4.1.1.2 through 4.1.1.5.

4.1.1.1 Alternatives Carried Forward for More Detailed Analysis

No Project Alternative

CEQA Guidelines section 15126.6(e)(2) states that the No Project analysis shall discuss the existing conditions at the time the Notice of Preparation is published, or if no Notice of Preparation is published, at the time environmental analysis is commenced, as well as what would be reasonably expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services. In this instance, the No Project Alternative would be no change from the current management conditions, other than as noted below, with the dams remaining in place. There is significant uncertainty about the long-term results if the KRRC's Proposed Project does not proceed. It is recognized that future consultations with the NMFS and the USFWS on the USBR's operation of the Klamath Irrigation Project, adaptive management of existing projects, and planned restoration activities can significantly alter conditions in the Klamath Basin, but the extent that these and other future basin activities would modify conditions is speculative. In light of this uncertainty, the No Project Alternative analysis focuses on the reasonably foreseeable period of 1–5 years), as described in Section 4.2.1.1 *[No Project Alternative] Alternative Description*.

Partial Removal Alternative

This alternative involves removal of Lower Klamath Project facilities at all four dam complexes to the extent sufficient to allow a free-flowing river. This alternative would therefore meet the underlying purpose and all the objectives of the Proposed Project. However, it would leave in place certain facilities described in Section 4.3.1.1 *Alternative Description*, thereby reducing the construction footprint and potentially the impact to historic resources from implementation of the Proposed Project. The KRRC has requested analysis of this scenario, indicating its feasibility, despite a lack of clarity regarding responsibility for long-term maintenance of remaining facilities.

Continued Operations with Fish Passage Alternative

This alternative examines the impacts of leaving the existing J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dam complexes in place and relicensing the dams before FERC for continued operations, but incorporating alterations to allow for anadromous fish passage. The Continued Operations of the Lower Klamath Project with Fish Passage Alternative is based on the 2007 FERC Staff Alternative with Mandatory Conditions (see Section 4.4 *Continued Operations with Fish Passage Alternative* for more details) and the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative*, but it has been updated based on the most recent requirements that would apply to fish passage at the dams. The alternative includes:

- Volitional, year-round upstream and downstream fish passage at J.C. Boyle, Copco No.1, Copco No. 2, and Iron Gate dams, consistent with the prescriptions from the DOI and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007), and upheld in a trial-type administrative hearing;
- Changes to J.C. Boyle operations to increase minimum flows, limit peaking flows (and recreation flows) to once per week;
- Changes to Copco No. 2 operations to increase minimum flows;
- Flows specified in the NMFS and USFWS 2013 BiOp for the USBR Klamath Irrigation Project (see also 3.1.6.1 *Klamath River Flows under the Klamath Irrigation Project's 2013 BiOp*);

- Court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam which became required after February 2017 (U.S. District Court 2017) (see also Section 4.2.1.3 *Summary of Available Hydrology Information for the No Project Alternative*); and
- Design and implementation of a Reservoir Management Plan.

Prior analyses of similar alternatives indicate a failure to meet the Proposed Project's underlying purpose of addressing project-related water quality impairments and its related objectives (FERC 2007, USBR and CDFG 2012). However, this alternative does further the underlying purpose of providing fish passage upstream of Iron Gate Dam and related objectives by providing volitional adult fish passage. A number of entities requested analysis of dams-in scenarios during Lower Klamath Project scoping: this scenario, with federal mandatory fish passage conditions and FERC-required modifications to operations to address some water quality impacts, fulfills that request and also describes a likely potential long-term condition should dam removal not occur. The Continued Operations with Fish Passage Alternative would reduce the potential impacts of the proposed project related to dam removal and restoration of a riverine environment and elimination of hydropower, and it would likely also reduce construction impacts.

Prior environmental analyses and/or Lower Klamath Project scoping have also raised trap and haul and fish cannons as methods that could allow fish passage with dams remaining in place (FERC 2007, State Water Board 2017). These methods are likely infeasible. Federal mandatory conditions specify volitional fish passage[178], and neither of these proposals have a project proponent. There are few specifics regarding where such facilities would be located and whether the use of the passage method is physically possible at various facilities. Fish cannons (e.g., Whooshh Innovations) present several implementation challenges for the Lower Klamath Project. Even if it is assumed that passage at J.C. Boyle Dam would be provided by a separate facility, the distance separating Iron Gate Dam and Copco 1 Dam (6 miles), along with the height of Iron Gate Dam (173 feet) are prohibitive to current fish cannon technology. To date, the longest distance and height of successful transport using fish cannon technology was 1,700 feet in length and 165 feet in height in a temporary demonstration implementation at Cle Elum Dam in Washington. If fish cannons were to be used at one or more Lower Klamath Project dams, it would most likely have to be in combination with other fish passage facilities at the remaining Lower Klamath Project dams; resulting in similar habitat access and migration mortality as for volitional fishways. In addition, a range of sizes of fish would need to be transported around the dams using the fish cannon technology, to account for fish ranging from relatively small Pacific lamprey or steelhead, to adult Chinook salmon. To date, a passive sorting system has not been developed for fish cannons. Passage of multiple sizes of fish would require multiple sizes of transport tubes, as well as an active sorting system, which has yet to be developed. Furthermore, NMFS considers fish cannons an experimental device. As fish cannons are not identified as a type of conventional fish passage facility by NMFS (2011), their use at the Lower Klamath Project dams would be experimental in nature and, consistent with Section 16.5 of NMFS (2011), would require design and development of conventional fish passage facility at each dam where experimental fish cannons would be used. To date, no implementation of fish cannon technology has successfully demonstrated safe,

[178] Fish passage made continuously available without trap and transport (NMFS 2011).

timely, or effective passage for listed anadromous species, and NMFS has not approved a design. Therefore, there is no evaluation or monitoring data of fish cannons from which to estimate potential mortality or injury to migrating fish if this technology were to be implemented at the Lower Klamath Project under the Continued Operations with Fish Passage Alternative. Thus, fish cannons are considered to be infeasible as a method for fish passage for the Lower Klamath Project in this and other alternatives involving fish passage. However, in light of strong public interest in analysis of alternative fish passage methods, and in light of the similarities among fish passage scenarios, this EIR provides information regarding where the impacts and mitigations for trap and haul would differ from those for fish ladders for the Continued Operations with Fish Passage Alternative, as well as other alternatives involving fish passage.

Two Dam Removal Alternative

In this alternative, the Copco No. 1 and Iron Gate dam complexes in California would be fully removed, while the J.C. Boyle dam complex in Oregon and Copco No. 2 dam complex in California would remain in place (see Section 4.5 *Two Dam Removal Alternative* for more details). This alternative assumes that the J.C. Boyle and Copco No. 2 dam complexes would be relicensed by FERC for continued operations under federal mandatory conditions, with changes to J.C. Boyle operations to increase minimum flows, eliminate peaking and/or recreational flows, and allow for a seasonal high flow event in late winter/spring, as well as fishway prescriptions to allow for volitional year-round upstream and downstream fish passage. Leaving the two dams in place would reduce the amount and duration of sediment release, reduce construction and waste disposal, and retain some level of hydropower production, thus reducing the associated potentially significant impacts. The extent of the reduction in impacts would be slightly greater for this two dam removal alternative compared to the three dam removal alternative described above. This alternative would further all the underlying purposes and project objectives, but not to the same extent as the Proposed Project. Objective 3 would not be met as completely under this alternative since anadromy would continue to be inhibited to some extent by the J.C. Boyle Dam and Reservoir, and to a lesser degree by the Copco No. 2 Dam and Reservoir. This could, in turn, affect the extent to which the alternative achieves Objective 2. This alternative was analyzed because it eliminates the reservoirs with the largest contributions to water quality impairment and with the tallest dams for fish ladder construction, while allowing for continued power generation.

Three Dam Removal Alternative

This alternative considers the potential impacts of removing the three California Lower Klamath Project dams, with J.C. Boyle operating under Mandatory Conditions, except that peaking flows would be completely eliminated (see Section 4.6 *Three Dam Removal Alternative* for more details). This alternative assumes that the J.C. Boyle facility would be relicensed by FERC for continued operations under federal mandatory conditions, with changes to J.C. Boyle operations to increase minimum flows, eliminate peaking and/or recreational flows, and allow for a seasonal high flow event in late winter/spring, as well as fishway prescriptions to allow for volitional year-round upstream and downstream fish passage. Retaining one dam would potentially reduce the amount and duration of sediment release, reduce construction and waste disposal and to retain some level of hydropower production, thus reducing associated significant impacts. The alternative would further all the underlying purposes and project objectives, but not to the same extent as the Proposed Project. It would not meet Objective 3 as completely because J.C. Boyle Dam and Reservoir would continue to inhibit anadromy to some extent. This could, in turn, affect the extent to which the project achieves Objective 2. Evaluation of this scenario was undertaken in light of the separate authority of the states of Oregon and California to issue water quality certification for the Proposed Project. Oregon issued water quality certification for the Proposed Project in September 2018, making this alternative unlikely. However, in light of the significant progress made in evaluating the scenario, and the analysis regarding the extent to which it meets project alternatives and avoids potential impacts, the State Water Board has determined to include the alternative in order to provide decisionmakers and the public with the information developed.

No Hatchery Alternative

This alternative is the Proposed Project, except with no hatchery operation during or after dam removal (see Section 4.7 *No Hatchery Alternative* for more details). The alternative would further the underlying purpose and most of the project objectives, although it is not clear at a screening level the extent to which the alternative would meet Objective 2. The alternative would reduce construction-related impacts of reopening Fall Creek Hatchery and making modifications at Iron Gate Hatchery. The alternative emerged from scoping concerns regarding the water source for the Iron Gate Hatchery, and in light of uncertainty regarding whether the Fall Creek Hatchery could be timely reopened.

4.1.1.2 Elimination of Potential Alternatives for Failure to Meet Underlying Project Purpose

A number of the potential alternatives fail to meet the basic underlying purpose of the Proposed Project because they (1) fail to address project-related water quality impairments within and downstream of the Lower Klamath Project; and/or (2) fail to expand anadromous fish habitat upstream of Iron Gate Dam. Potential alternatives eliminated based upon this criterion are described below.

2007 FERC PacifiCorp's Proposal (for Continued Operation of the Klamath Hydroelectric Project)

This alternative in the 2007 FERC EIS proposes removing Keno and Link River facilities from the Klamath Hydroelectric License, and continuing operation of other facilities with implementation of a Reservoir Management Plan, improvement of existing fish passage facilities at J.C. Boyle Dam, and other operational changes. The 2007 FERC EIS found that PacifiCorp's Proposal failed to address the project's water quality impairments within and downstream of the hydroelectric reach (FERC 2007). Additional studies since 2007 have indicated that proposed reservoir management techniques can improve some of the project impacts to water quality (e.g., transport of nuisance and/or noxious blue-green algae downstream of Iron Gate Dam), but the various techniques have not been shown to sufficiently improve project impacts to water quality (e.g., dissolved oxygen) to meet all the water quality requirements (Carlson and Foster 2008, 2009; Deas et al. 2009; Horne et al. 2009; PacifiCorp 2008, 2011, 2013a, 2013b, 2014, 2015, 2017, 2018; Deas et al. 2012; CH2M HILL 2013, 2015; Austin et al. 2016). Because the proposal does not include fish passage, it also fails to extend anadromous fish habitat upstream of Iron Gate Dam. In addition to failing to meet either underlying project purpose, PacifiCorp is not currently pursuing this alternative, having asked for and received a stay in FERC proceedings to allow consideration of the KRRC's Proposed Project. The alternative also does not appear to be legally feasible, even if FERC were to lift the stay in the relicensing proceeding, as it does not include federal mandatory relicensing conditions.

2007 FERC Staff Alternative

This potential alternative, analyzed in FERC's 2007 EIS, modifies PacifiCorp's Proposal detailed in FERC (2007) to include fish disease studies, turbine venting, limited trap and haul with associated studies, and other improvements to Klamath Hydroelectric Project operations that would reduce ongoing impacts. The FERC 2007 EIS found that the alternative failed to meet water quality standards within and downstream of the Hydroelectric Reach (FERC 2007). Thus, this alternative would not achieve the project's underlying purpose of addressing project-related water quality impairments. The alternative also does not appear to be legally feasible, even if FERC were to lift the stay in the relicensing proceeding, as it does not include federal mandatory relicensing conditions.

Bogus Creek Bypass

This proposed alternative envisions a fish bypass reach from below Iron Gate to above Copco 1 Dam, using primarily the natural waterways of Bogus Creek, Cold Creek, and Little Deer Creek, with a constructed canal that would connect to Copco No. 1 Reservoir. The alternative proposes upstream fish passage via Bogus Creek, upstream into Cold Creek, through a constructed canal from Cold Creek to Deer Creek on the other side of a ridgeline, and moving downstream from Deer Creek into Copco No. 1 Reservoir. It assumes downstream fish passage for outmigrating juveniles is possible from Copco No. 1 Reservoir to the Klamath River below Iron Gate in the reverse direction, but it does not provide any examples of similar projects where this occurs to demonstrate its feasibility. This alternative fails to meet the underlying purpose of addressing project-related water quality impairments. Additionally, it would be extremely unlikely to meet the underlying objective of extending anadromous fish habitat above Iron Gate Dam since key elements of the alternative do not comport with known behavioral traits of adult salmonids preventing their usage of the bypass; the steep gradient and low flow in streams involved in the bypass would restrict migration; and it does not address the needs of outmigrating juvenile salmonids (CDFG 2009; White 2011). The migratory behavior of adult salmon to swim upstream to spawn would lead to spawning in the highest reaches of the bypass route rather than migration through the tunnel and spawning upstream of Copco No. 1 Reservoir (White 2011). The alternative also is not viable because the amount of water required to provide passage for salmonids through the bypass exceeds the amount of water currently available in Cold Creek or Deer Creek and no alternative source has been currently identified. Additionally, the alternative does not meet screening-level indications of feasibility, as there is no funding, no project proponent with the authority to implement it, and no indication that the project could be implemented in a timely manner.

Bogus Creek Bypass with Alternative Tunnel Route

This proposed alternative is a modification of the Bogus Creek Bypass above, that would use Bogus Creek and a five-mile tunnel to Copco No. 1 Reservoir. In this alternative, upstream fish passage would occur with fish in the Klamath River entering Bogus Creek, swimming from Bogus Creek into a constructed 4.75-mile tunnel, and moving downstream through the tunnel into Copco No. 1 Reservoir. Downstream fish passage from Copco No. 1 Reservoir to the Klamath River downstream of Iron Gate would occur in the reverse direction. The alternative addresses some of the constraints of the Bogus Creek Bypass alternative related to the underlying purpose of fish passage above Iron

Gate Dam, in that it avoids the concern about requiring adult salmonids to swim downstream during their upstream migration. Additionally, it addresses flow constraints in Cold Creek. However, a review of the alternative concluded that the tunnel alternative would be a very high risk option that may not provide effective fish passage because substantial data on the migratory behavior of adult salmon show the tunnel would eliminate many of the natural stimuli for fish migration and salmon have a general, although not absolute, avoidance of movement through culverts and short tunnels. Predicting fish movement through the 4.75-mile tunnel proposed in this alternative would be risky and there would be little flexibility in the alternative if fish avoided using the tunnel for migration (Mefford 2011). Additionally, because the tunnel would not maintain the ecological function of the stream to promote fish passage and it would not adhere to NMFS conventional fish passage design guidelines (NMFS 2011), its use would be experimental in nature and, consistent with Section 16.5 of NMFS (2011), would require design and development of a conventional fish passage facility at any location where it would be used. Further, the alternative does not include provisions for collecting and bypassing outmigrating juvenile fish. As proposed, it is expected only a small portion of juvenile fish would follow the low flows into the tunnel rather than the high flows downstream through the reservoir, so fish passage effectively would not be achieved (Mefford 2011; White 2011). The project's underlying purpose of addressing project-related water quality impairments would also not be achieved, with the tunnel providing no ecological benefit to the river and potentially further degrading the ecology of the river within this reach by diverting water from the river for the tunnel (Mefford 2011). Additionally, the alternative does not meet screening-level indications of feasibility, as there is no funding, no project proponent with the authority to implement it, and no indication that the project could be implemented in a timely manner.

Federal Takeover

This alternative entails a federal agency assuming control over the dams. That entity would then determine the fate of the facilities. Because this alternative does not involve particular operational or structural changes, it does not further the underlying project purposes of addressing project-related water quality impairments or expanding anadromous fish habitat. There is also no indication that this alternative is feasible, as no federal agency has indicated an interest in federal takeover. Further, because the alternative is a change in ownership, rather than in outcome, it fails to reduce the potentially significant impacts of the Proposed Project in a manner different from the evaluated alternatives. This EIR evaluates a reasonable range of alternatives that could be the outcome of the proposed process by the KRRC, or of ownership and management by a different entity.

Cessation of Power Production with Dams in Place

This alternative would end power production at the facilities, but not remove or modify them. Ceasing power production would not meet the underlying project purposes of addressing water quality impairments or expanding anadromous fish habitat beyond Iron Gate Dam. Additionally, this alternative does not meet screening-level indications of feasibility. Maintenance of the facilities would be costly, and eliminating power production would remove the facilities' primary earnings potential. No entity has stepped forward to operate the dams as non-power facilities.

Dredge Upper Klamath Lake

This alternative involves removing sediments from Upper Klamath Lake in Oregon, in order to reduce nutrients and to increase storage capacity of the lake. This action would not address the underlying project purpose of expanding anadromous fish habitat. The extent of required dredging to affect the phosphorus balance in Upper Klamath Lake is unclear, and the process would not remove nitrogen from the system. Thus, it is not clear the extent to which it would achieve a nutrient reduction sufficient to improve water quality in the hydroelectric reach. The alternative does not address facility-related water quality impairments that do not depend on phosphorus input in Upper Klamath Lake, such as the seasonal shift in water temperature, hydromorphology impacts, sediment starvation of the reach downstream of Iron Gate Dam, nuisance and/or noxious blue-green algae blooms within the reservoirs and potential transport of blue-green algae from the reservoirs into the Klamath River downstream of the reservoirs, and the contribution of these impacts to fish disease. Thus, it fails in large part to achieve the project's underlying purpose of addressing project-related water quality impacts. Additionally, the project does not meet screening level indications of feasibility because expansive dredging is high-cost, creates a large amount of dredged material for disposal (Stillwater Sciences et al. 2013), and there is no identified proponent to take on this activity. The location of the action outside of California creates additional barriers to feasibility from a CEQA perspective.

Predator Control

This alternative proposes controlling sea lion, seal, and cormorant populations on the coast, in order to reduce predation of adult and juvenile salmonids. It has been suggested that predation of anadromous salmonids by these marine species is having a major effect on the salmonid population as they return to the Klamath River to spawn. A number of seal and sea lion haul outs and sea bird colonies exist in the vicinity of the mouth of the Klamath River, but no studies have been conducted to determine the impact of these predators on Klamath River populations. Observations of sea lion and seal predation on salmonids in the Columbia or Willamette rivers have estimated approximately 0.3 to 5.5 percent of the adult return is consumed by sea lions or seals (NOAA 2006), with 2014 to 2017 data from the Willamette River showing the average percent of potential escapement eaten be sea lions ranging from 6 to 9 percent of Chinook and 3 to 25 percent of steelhead (ODFW 2017). Analysis of Chinook salmon consumption from California to Alaska shows an increasing trend in salmonid predation by sea lions and seals from 1975 to 2015 as their populations increase (Chasco et al. 2017). The impact of avian predators, such as gulls, cormorants, and certain species of ducks, on out-migrating smolts in the Columbia River at reservoirs concluded that avian predators in the reservoirs accounted for the mortality of less than one percent of the juvenile salmonid population (Wiese et al. 2008). Similar percent reductions in the salmonid populations in the Klamath River may occur. This alternative would not meet the underlying purposes of expanding anadromous fish habitat beyond Iron Gate Dam. Additionally, it would not address downstream project-influenced water quality conditions, including the seasonal shift in water temperature, hydromorphology impacts, sediment starvation of the reach downstream of Iron Gate Dam, nuisance and/or noxious blue-green algae blooms within the reservoirs and potential transport of blue-green algae from the reservoirs into the Klamath River downstream of the reservoirs, and the contribution of these impacts to fish disease. Additionally, the alternative does not meet screening-level indications of feasibility, as there is no funding, no project proponent with the authority to implement it, and no indication that the project could be implemented in a timely manner.

Partition Upper Klamath Lake

This alternative would create an "inner lake" in Upper Klamath Lake, which would reduce residence time in the lake, and potentially improve water quality (Herald and News 2010). This action would not meet the underlying purpose of expanding anadromous fish habitat beyond Iron Gate Dam. Additionally, it would not address downstream project-influenced water quality conditions, including the seasonal shift in water temperature, hydromorphology impacts, sediment starvation of the reach downstream of Iron Gate Dam, nuisance and/or noxious blue-green algae blooms within the reservoirs and potential transport of blue-green algae from the reservoirs into the Klamath River downstream of the reservoirs, and the contribution of these impacts to fish disease. There is no indication that there is available funding for this project, or that there is an entity capable of and interested in performing it, so it does not meet initial screening indicators for feasibility. Additionally, it is outside of California, further casting doubt on the alternative's feasibility for CEQA purposes.

Water Storage Development in the Scott and Quartz Valleys

This alternative would involve constructing additional storage facilities in the Scott and/or Quartz Valley and releasing stored water into the Scott River to improve conditions in the Scott and Klamath rivers. In a previous study, two potential reservoir sites with a 20,000 acre-feet capacity per reservoir were identified in the East Fork Scott River sub-watershed (DWR 1991), with releases from these reservoirs potentially improving water quality downstream in the Scott River and eventually the Klamath River. However, the alternative does not meet the underlying project purpose of extending anadromous fish habitat above Iron Gate Dam. Additionally, there has been no quantification of the amount of water needed to sufficiently improve water quality in the Klamath River. A previous study of environmental water releases in the Scott River highlighted that current water temperatures in portions of the Scott River are too warm for anadromous fish, and there is significant uncertainty about whether environmental water releases would adequately improve water temperature (DWR 1991). The alternative also would not address water quality impacts upstream of the Scott River (e.g., the Hydroelectric Reach of the Klamath River) or other impacts of the dam, including the seasonal shift in water temperature, hydromorphology impacts, sediment starvation of the reach downstream of Iron Gate Dam, nuisance and/or noxious blue-green algae blooms within the reservoirs and potential transport of blue-green algae from the reservoirs into the Klamath River downstream of the reservoirs, and the contribution of these impacts to fish disease. The alternative does not meet screening levels of feasibility: there is no project proponent with the authority to implement it, no analysis of water quantity needed to sufficiently improve the mainstem Klamath River water quality, and no indication that the two identified reservoir sites would have sufficient storage to meet the water quantity needed.

Transfer Water from Klamath River to Shasta River

This alternative would involve constructing a canal to transfer 60,000 acre-feet of water from Iron Gate Reservoir (or J.C. Boyle Reservoir or Keno Reservoir) to the Shasta River sub-watershed as irrigation supply to allow Lake Shastina discharges to go directly into the Shasta River rather than being used as irrigation supply first. This alternative does not meet the underlying project purpose of extending anadromous fish habitat above Iron Gate Dam. While releasing water from Lake Shastina directly into the Shasta River may improve water quality in the reaches downstream of the releases, there has been no quantification of the impact of flow releases from Lake Shastina on water quality in the Klamath River or whether sufficient water is available to be released from Lake

Shastina to sufficiently improve water quality in the Klamath River. Additionally, this alternative does not have the potential to address water quality impacts upstream of the Shasta River (e.g., the Hydroelectric Reach of the Klamath River) or other impacts of the dam, including the seasonal shift in water temperature, hydromorphology impacts, sediment starvation of the reach downstream of Iron Gate Dam, nuisance and/or noxious blue-green algae blooms within the reservoirs and potential transport of blue-green algae from the reservoirs into the Klamath River downstream of the reservoirs, and the contribution of these impacts to fish disease. The alternative does not meet screening levels of feasibility: there is no project proponent with authority to implement it, no analysis the impact of flow releases from Lake Shastina on improving Klamath River water quality, and no analysis of water quantity and availability needed to sufficiently improve the mainstem Klamath River water quality.

4.1.1.3 Removal or Consolidation of Substantially Similar Alternatives

CEQA requires an EIR to examine a reasonable range of alternatives to foster informed decision-making, rather than to evaluate all possible alternatives or permutations thereof (CEQA Guidelines section 15126.6, subd. (a).) Therefore, when identified alternatives provided only minor variations of the same primary elements, the State Water Board either eliminated the closely-linked alternatives from consideration or analyzed an alternative that combines various aspects of the slightly different potential alternatives.

Alternatives Similar to Removal of Four Dams

The Proposed Project is substantially similar to the 2007 FERC Four-Dam Removal alternative; the rejected KHSA EIS/EIR Dam Removal of Four Dams Without KBRA alternative; and the KHSA EIS/EIR Project Full Facilities Removal of Four Dams. Because all of these alternatives analyze the major impacts of removing four major dam facilities, the State Water Board has moved forward only the analysis of the Proposed Project, rather than analyzing all four variations. The Proposed Project, as it is currently being proposed, has funding and has the backing of a range of stakeholders under the Klamath Hydroelectric Settlement Agreement. Additionally, it incorporates additional studies and information on feasible methods of dam removal vis-à-vis the other potential alternatives. The Proposed Project is therefore more feasible than the other similar four-dam removal scenarios.

The alternatives of Notching Four Dams, and Partial Removal of Four Dams have a significant overlap: both reduce the extent of facilities removal as compared to the Proposed Project. Therefore, the potential alternatives will likely both reduce construction-related impacts vis-à-vis the Proposed Project. Both alternatives would also require some sort of monitoring or other actions regarding the remaining project facilities. Here, the KRRC has proposed Partial Removal as an alternative, indicating potential feasibility of the alternative, but it has not proposed evaluation of notching. A notching alternative would be highly dependent on successful dam demolition and notching during winter months, with the following identified constructability and schedule risks: safety of construction workers operating on narrow, steep access roads during winter months with wet and icy conditions; weather delays that are likely to be worse in the wettest years when reservoir drawdown would rely on notching more than in dry years; and incomplete reservoir drawdown during wet years if notching is not complete. Additionally, Iron Gate Dam is an earthen dam that cannot be notched. Therefore, the State Water Board has elected to review Partial Removal of Four Dams as the more feasible and reasonable alternative between the two reduced-construction proposals.

Alternatives Similar to Retaining All Facilities

A number of alternatives contemplate retaining existing facilities and continuing power generation, but undertaking facility modifications to allow for passage of anadromous fish. All of these alternatives would reduce the Proposed Project's potentially significant impacts to a range of resources affected by removal of the facilities, including impacts from changes to hydrology, sediment release, elimination of reservoirs, and removal of facilities of potentially historic significance. Additionally, maintaining the dams has the potential to reduce the intensity of construction-related impacts, as construction of fish passage facilities requires less activity than dam deconstruction. The proposals also contain a significant weakness in meeting the habitat expansion purpose in that the technologies are better suited to accommodating upstream migration of spawning salmonids than they are to downstream migration of juveniles. They also have similar weaknesses in meeting the water quality and fisheries improvement purposes and objectives because they maintain the reservoirs, with associated water quality problems.

The EIR evaluates the most well-developed dams-in alternative which comports with federal mandatory conditions and includes FERC staff's proposed corresponding operational and physical modifications to the existing project. There are also proposals to use different technologies than those described in federal mandatory conditions in the Klamath Hydroelectric Project's relicensing process. For example, the 2007 FERC Staff Alternative included a testing protocol for determining whether trap and haul between various locations would be able to successfully expand anadromous fish habitat (FERC 2007). Scoping comments in this process have recommended evaluation of trap and haul, but they have also recommended evaluation of a new technology that has emerged in recent years—the use of fish cannons to lift fish over dams. However, trap and haul and other alternative technologies would not meet federal mandatory conditions and fish cannons are considered experimental (Section 16.5 of NMFS [2011]), so NMFS guidelines for experimental technologies would be needed, including construction of a conventional back-up fish passage design (see also Section 4.1.1.1 *Alternatives Carried Forward for More Detailed Analysis – Continued Operations with Fish Passage*). Additionally, no concrete plans or proponents for undertaking fish passage through trap and haul or other alternate measures exist. In light of the above, these proposals are likely infeasible. However, in light of the public's high degree of interest in fish passage alternatives, the EIR notes where the environmental impacts of trap and haul would differ from the fishways required under federal mandatory conditions.

Alternatives Similar to Removal of Fewer Facilities

Both the 2007 FERC EIS and the 2012 KHSA EIS/EIR analyzed an alternative of removing Iron Gate and Copco No. 1 dams, while leaving Copco No. 2 and J.C. Boyle dams in place with fish passage. The 2012 KHSA EIS/EIR also rejected the potential alternative of Three Dam Removal, removing all three California facilities and leaving J.C. Boyle Dam in place. Removing fewer facilities would allow for hydropower production, reduce the amount of construction and disposal of waste, and reduce the amount and duration of sediment releases, with potential reductions to the associated Project impacts. These alternatives would further both the water quality and fish habitat underlying project purposes, and would further all project objectives, but not to the same extent as the Proposed Project. Water quality under these alternatives would likely show improvement in the Hydroelectric Reach and downstream of Iron Gate Dam, with the elimination of the seasonal shift in water temperature, reduction in the hydromorphology impacts, decreased sediment starvation of the reach downstream of Iron Gate Dam, elimination of nuisance and/or noxious blue-green algae blooms within the Iron Gate and Copco No. 1 reservoirs and potential transport of blue-green algae from the reservoirs into the Klamath River downstream of the reservoirs, and the contribution of these impacts to fish disease. However, the remaining dam(s) and reservoir(s) in these potential alternatives may limit the improvements and achievement of Objective 1 due to power production operations altering flow and potentially water temperature and the reservoir(s) retaining some sediment. The remaining dam(s) and reservoir(s) in these potential alternatives also would continue to inhibit adult and juvenile migration to some extent, limiting achievement of Objective 3. This, in turn, has the potential to affect the ability to meet Objective 2.

Copco No. 2 is a relatively small facility, with a dam only 33 feet high and a reservoir approximately 0.25-mile long with a storage capacity of 73 acre-feet (FERC 2007). Therefore, keeping the facility in place and building fish passage would not significantly reduce the sediment releases and associated water quality impacts from those releases or the construction and disposal impacts compared to the Proposed Project. Hydropower production is possible at this facility absent the presence of Iron Gate Dam to moderate peaking downstream, although production would be considerably less than under existing conditions. No party is proposing operation of J.C. Boyle Dam or Copco No. 2 Dam independent of any other Lower Klamath Project facilities.

In light the above, this EIR reviews the Three Dam Removal and Two Dam Removal scenarios as alternatives that analyze removal of fewer facilities than proposed.

4.1.1.4 Elimination of Potential Alternatives that Would Not Avoid or Substantially Lessen Significant Environmental Effects of the Proposed Project

Alternatives for Removing Additional Facilities

Scoping comments in this process have suggested analysis of alternatives that would remove not only the Lower Klamath Project facilities, but also additional facilities in Oregon—Keno and Link River Dams. The 2012 KHSA EIS/EIR and the 2007 FERC EIS noted, but they did not analyze these alternatives. Proponents of these alternatives emphasize the potential habitat expansion benefits of these alternatives. However, the proposed Five and Six Dam Removal alternatives would not reduce the potential significant impacts of removing the four lower facilities under the Proposed Project. Additionally, these upstream facilities are not part of the Lower Klamath Project. Keno and Link River Dams are components of the Klamath Irrigation Project as well as being part of the Klamath Hydroelectric Project, and the facilities provide water for consumptive use in Southern Oregon and Northern California. PacifiCorp has proposed removing the facilities from hydroelectric production, but neither USBR, nor the water users that rely on these facilities have put forth a proposal to remove them. Comments have identified no funding mechanism, water replacement, or concrete proposal for removal. Thus, in addition to not reducing the potential impacts of the Proposed Project, these alternatives are not feasible.

Sequenced Removal of Four Dams

Sequenced Removal of Four Dams contemplates an alternate method of dam removal than that in the Proposed Project. Rather than removing all four facilities in an overlapping timeframe in a single season, sequenced removal would remove facilities one at a time. This would reduce the concentration of sediment released, as sediments would be released over an extended period of time. Additionally, depending on the amount of time between removals, it could allow for evaluation of model assumptions and restoration methods. Analysis of sequenced removal indicates that the reduced concentration of sediment from removing a single facility at once would not significantly reduce mortality during removal. The Proposed Project's timing is proposed to minimize the duration of sediment release, and to have the high concentrations of sediment occur at a time that interferes least with the life stages of the different fish populations in the Klamath system. Sequenced removal over three to five years likely would result in drawdown and repeated refills of reservoirs, based on modeling of more rapid drawdown during individual water year types for the Proposed Project showing some refill occurring under all water year types except Dry (Appendix B: *Definite Plan*). Sequenced removal would result in elevated suspended sediment concentrations over a longer time than the Proposed Project impacting additional life stages of fish, additional year-classes of fish, or both (Stillwater Sciences 2011). Elevated suspended sediments would be sufficiently high that the adverse impacts to water quality and fish would still occur during the sequenced removal even though the maximum suspended sediment concentration likely would be reduced compared to the Proposed Project. As such, sequenced removal would extend, rather than reduce, the impacts to fish species. Because of the increased duration of impact over more life stages and/or additional year-classes, it is unclear whether sequenced removal would fulfill Objective 2 of advancing the long-term restoration of the natural fish populations in the Klamath Basin. Additionally, sequenced removal would extend the time before other objectives would occur, so they would not be achieved in as timely a manner as under the Proposed Project.

4.1.1.5 Alternatives With Other Feasibility Concerns

The 2012 KHSA EIS/EIR included implementation of the Klamath Basin Restoration Agreement (KBRA) as a coordinated action for alternatives that implemented the KHSA. The KBRA has expired, and stakeholders have not reached a similar agreement. While negotiations regarding such an agreement are ongoing, it is speculative at this point to assume whether agreement will be reached, when, and what such an agreement would look like. Therefore, the EIS does not analyze any KBRA-implementation alternatives.

4.2 No Project Alternative

4.2.1 Introduction

4.2.1.1 Alternative Description

The No Project Alternative describes the environment should the Klamath River Renewal Corporation's (KRRC's) Proposed Project to decommission the Lower Klamath Project not proceed. California Environmental Quality Act (CEQA) Guidelines Section 15126.6(e)(2) states that "The 'no project' analysis shall discuss the existing conditions at the time the notice of preparation is published, or if no notice of preparation is published, at the time environmental analysis is commenced, as well as what would be reasonably expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services." Specifically, where a CEQA document concerns revisions to an ongoing operation, "the 'no project' alternative will be the continuation of the existing … operation into the future."

In this instance, in the short term, the No Project Alternative would be no change from the current management conditions, other than as noted below with regard to 2017 flow requirements and cessation of certain KHSA measures related to water quality and habitat. The Lower Klamath Project facilities would remain in place and operate under annual FERC licenses. This short-term scenario is anticipated for the duration of the FERC proceeding for relicensing of the hydroelectric facilities, estimated at one to five years, depending on the time necessary to obtain water quality certification from California and Oregon, on the time to obtain Clean Water Act section 404 permits from the Army Corps of Engineers for construction work, and on whether Federal Energy Regulatory Commission (FERC) and the Army Corps of Engineers relies on existing environmental reviews. It also includes time to conduct planning and monitoring required prior to facilities modification and/or removal.

The outcome of such a proceeding has not yet been determined, although there are bounds to the uncertainty. It is clear that the continued operation of the Lower Klamath Project as permitted under annual licenses is infeasible, as federal agencies have imposed fish passage requirements, ramping requirements, and other significant changes to the Lower Klamath Project dam complexes and operations in the context of the PacifiCorp Klamath Hydroelectric Project relicensing (FERC Project No. 2082). These requirements were challenged and upheld under a trial-type administrative hearing (Section 241 of the Energy Policy Act of 2005). Additionally, any relicensing procedure would have to comply with conditions to meet water quality standards in California and in Oregon, and it is not clear that this would be possible with all (or perhaps any) of the Lower Klamath Project dams and reservoirs in place.

Projecting one specific No Project scenario for the long term would be speculative, in light of the above, and would be contrary to the CEQA Guidelines' mandate to disclose and assess the environmental impacts that would "reasonably be expected to occur in the foreseeable future." The potential future for the existing hydroelectric facilities could include the transfer, decommissioning, or relicensing with modifications of all or some of the dams and associated facilities. However, this Environmental Impact Report (EIR) addresses the environmental effects of a range of potential long-term operation and decommissioning scenarios that could occur: all of the dams remain in place with fish passage (Section 4.4 *Continued Operations with Fish Passage Alternative*); removal of all (or substantially all) of the facilities (Proposed Project, Sections 2 and 3, Section 4.3 *Partial Removal Alternative*, Section 4.7 *No Hatchery Alternative*) or some of the dams, with fish passage on the remaining facilities (Section 4.5 *Two Dam Removal Alternative* and 4.6 *Three Dam Removal Alternative*). Therefore, while the long-term effects of the No Project Alternative cannot reasonably be ascertained with specificity, the range of potential long-term effects are found in the Proposed Project and the other alternatives.

In light of this uncertainty, the No Project Alternative analysis focuses on the reasonably foreseeable period of 0−5 years, as described below. Citations to the Proposed Project and other alternatives are provided for ease of reference in examining the effects of not implementing the Proposed Project in the long term.

Foreseeable Short-term Operations

For the next zero to five years, the Lower Klamath Project (i.e., J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities) and the remaining Klamath Hydroelectric Project facilities (East and West Side Powerhouses, Keno Dam, Fall Creek dam complexes—see also Section 2.6.2 *Relationship with Klamath Hydroelectric Project*) would continue to operate under annual licenses issued by FERC while the disposition of all the Lower Klamath Project facilities would be determined through the FERC relicensing process. This would include the potential of reaching another settlement agreement under that process. This timeframe also includes time for completion of any necessary planning or studies to undertake facilities modifications. The current annual license issued for Lower Klamath Project facilities under PacifiCorp's annual FERC licenses for Project No. 2082 has no requirements for additional fish passage or implementation of the prescriptions that are currently before FERC in the relicensing process. In the No Project Alternative analysis, the existing environmental conditions associated with the Lower Klamath Project and its operations would continue except as modified by:

- Court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam, which became required after February 2017 (U.S. District Court 2017)

Please see Section 4.2.1.1 *[Alternative Description] Summary of Available Hydrology Information for the No Project Alternative* for a discussion of the effect of this addition on the analysis of the No Project Alternative).

- The cessation of certain interim measures (IMs) from the KHSA, as discussed in Section 4.2.1.1 *[Alternative Description] KHSA Interim Measures*. Some of these measures would continue to form part of the existing conditions, while others would cease.

There are various efforts underway in the Klamath Basin to improve water quality, as discussed in Section 3.24 *Cumulative Effects*. However the effects of these efforts, including efforts aimed at meeting Klamath River TMDLs are not analyzed for the reasonably foreseeable period under the No Project Alternative because the basin response to the restoration measures to meet the total maximum daily loads (TMDLs) during the short-term is too speculative.

Long-term water quality improvements that bring water quality in the Klamath Basin closer to the load allocations established in the TMDLs are foreseeable through a variety of implementation measures. However, TMDLs are not self-implementing, and the extent of reasonably foreseeable financial resources are insufficient to implement the extensive efforts necessary to meet TMDL goals. While the TMDLs are expected to result in improvements to water quality conditions over time, the pace of attaining improvements and the specific implementation measures are not fully known. Additionally, the Klamath River TMDL includes load allocations for Copco No. 1 and Iron Gate reservoirs. As discussed in Section 3.2 *Water Quality*, removing the dams under the Proposed Project would rapidly and substantially move the Hydroelectric Reach and the Klamath River downstream of Iron Gate Dam towards achieving compliance. However, it is not clear the extent to which the allocations can be met absent dam removal, and within what timeframe. Water quality improvement measures in Oregon and California due to the Klamath TMDLs would result in long-term changes in water quality, so they are analyzed as part of the Proposed Project and other alternatives.

Summary of Available Hydrology Information for the No Project Alternative

Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* describes information regarding the EIR's analysis of the 2013 Biological Opinion (BiOp) flow requirements.

In addition to the 2013 BiOp Flows, and until the reinitiated formal consultation is complete, the USBR is also required to manage *Ceratanova Shasta (C. Shasta)* infection among coho salmon in the Klamath River with additional winter-spring surface flushing flows and deep flushing flows, as well as emergency dilution flows. Flushing flows are designed to dislodge and flush out polychaete worms that host *C. Shasta* in the Klamath River. Emergency dilution flows were developed to reduce *C. Shasta* infections in coho salmon if certain disease thresholds in the Klamath River are exceeded. The details of the flushing flow and emergency dilution flow requirements are outlined in *Measures to Reduce Ceratanova Shasta Infection of Klamath River Salmonids: A Guidance Document* and US District Court Filing 111 (U.S. District Court 2017). The flushing flow and emergency dilution flow requirements include:

- Releasing surface flushing flows every year from Iron Gate Dam of at least 6,030 cfs for a 72-hour period during the winter period (November 1–April 30) sufficient to move surface sediments.
- Releasing deep flushing flows at least every other year (beginning in 2017) with the Klamath River flow measured at Iron Gate Dam averaging at least 11,250 cubic feet per second (cfs) over a single 24-hour period between February 15 and May 31, unless USBR determines that such flows are limited and/or precluded by inherent hydrologic, infrastructure, and/or public safety constraints.
- Releasing emergency dilution flows of downstream of Iron Gate Dam between April 1 to June 15 or when 80% of juvenile Chinook Salmon outmigration has occurred if either: (1) spore concentrations exceed five spores (non-specified genotype) per liter for the preceding sample based on quantitative polymerase chain reaction (qPCR) from water filtration samples at any sampling station, or (2) the prevalence of inflection (POI) of all captured juvenile Chinook salmon (both wild and hatchery) exceeds 20 percent in aggregate for the preceding week at the Kinsman Rotary Screw Trap. Emergency dilution flows are 3,000 cfs measured at Iron Gate Dam until spore or POI at Kinsman Trap decreases if flows at Iron Gate Dam are below 3,000 cfs when disease thresholds are met or exceeded. Emergency flows at Iron Gate Dam are maintained at 3,000 cfs or increased from 3,000 cfs to 4,000 cfs if disease levels remain above disease thresholds after flows

at Iron Gate Dam have been 3,000 cfs for at least seven days. The volume of emergency dilution releases is capped at 50,000 acre-feet (AF).

The requirements of the flushing and emergency dilution releases are in addition to the 2013 BiOp flow requirements, which must still be met by USBR. Water released during flushing and emergency dilution flows are not part of the Environmental Water Account detailed in the 2013 BiOp. The exact timing of the releases of flushing flows is left to the discretion of USBR, provided they occur within the specified timeframes for the releases. Provisions for adaptive management of the flushing and emergency dilution flows exist, provided consensus for an amended flow plan is reached among the applicable agencies and submitted to the U.S. District Court for the Northern District of California San Francisco Division.

The additional surface and deep flushing flows, along with the emergency dilution flows to manage *C. Shasta,* are within the range of historical Klamath River flows evaluated in the 2013 BiOp studies. For example, while infrequent (i.e., less than 1 percent of the time at Iron Gate Dam), daily average flows in the Klamath River exceed the deep flushing flow requirement of 11,250 cfs during some storm events in the period of analysis. Additionally, the duration of a deep flushing flow event is short (i.e., 24 hours plus the time to ramp down the flushing flow) and is designed to occur every other year (beginning in 2017), such that the overall period that deep flushing flows influence Klamath River hydrology is limited.

In summary, river flow-related environmental impacts under the EIR No Project Alternative are evaluated by synthesizing the existing 2013 BiOp hydrology including the winter-spring surface and deep flushing flows as well as emergency dilution flow requirements, the No Project Alternative hydrology analysis presented in the 2012 KHSA EIS/EIR (which is modeled using 2010 BiOp Flows), and the technical studies that supported the 2012 KHSA EIS/EIR. Additional analysis is undertaken when necessary to evaluate how the flushing and dilution flows impact conditions in the Klamath Basin.

KHSA Interim Measures

The KHSA includes a series of “interim measures” (IMs) (KHSA Section 1.2.4) that have been implemented by PacifiCorp since 2010 to assess and address environmental conditions and improve fisheries prior to dam removal. The KHSA defines the interim period as the period between the date that the KHSA was originally executed (February 18, 2010 (i.e., the Effective Date) and PacifiCorp’s physical removal from a facility of any equipment and personal property that PacifiCorp determines has salvage value, and physical disconnection of the facility from PacifiCorp’s transmission grid (i.e., Decommissioning). However, some of the IMs were either one-time measures that were already completed, or have been integrated into PacifiCorp’s annual licenses as part of an Interim Conservation Plan (ICP). Additionally, it is assumed that flow and peaking operations associated with J.C. Boyle as specified in IMs 13 and 14 would continue. The ICP measures, therefore, form part of the existing conditions under the No Project Alternative. Assumptions regarding ICP and Non-ICP IMs are presented in Table 2.7-19.

Table 4.2-1. KHSA Interim Measures Relevant to California Under the No Project Alternative Compared with Existing Conditions and the Proposed Project.

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	No Project Alternative	Proposed Project
IM1 – Interim Measures Implementation Committee (IMIC)	ICP	The IMIC is comprised of representatives from PacifiCorp, other parties to the KHSA (as amended on November 30, 2016), and non-signatory representatives from the State Water Board and Regional Water Board (see KHSA Appendix B, Section 3.2). The purpose of the IMIC is to advise on implementation of the Non-Interim Conservation Plan Interim Measures set forth in Appendix D of the Amended KHSA.	Ongoing	Would continue	Would continue separate from the Proposed Project[2]
IM2 – California Klamath Restoration Fund/Coho Enhancement	ICP	PacifiCorp would fund actions to enhance survival and recovery of coho salmon, including habitat restoration and acquisition.	Ongoing	Would continue	Would not continue
IM3 – Iron Gate Turbine Venting	ICP	PacifiCorp shall implement turbine venting on an ongoing basis beginning in 2009 to improve dissolved oxygen concentrations downstream of Iron Gate Dam.	Construction complete, implementation ongoing	Would continue	Would not continue
IM4 – Hatchery and Genetics Management Plan (See also IM19 and IM20)	ICP	PacifiCorp would fund the development and implementation of a Hatchery and Genetics Management Plan for the Iron Gate Hatchery.	Plan development is complete, implementation ongoing	Implementation would continue	Implementation would continue for eight years after removal of Iron Gate Dam as part of the Proposed Project, see also IM19 and IM20

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	No Project Alternative	Proposed Project
IM5 – Iron Gate Flow Variability	ICP	PacifiCorp and USBR would annually evaluate the feasibility of enhancing fall and early winter flow variability to benefit salmonids downstream from Iron Gate Dam. In the event that fall and early winter flow variability can feasibly be accomplished, PacifiCorp would develop and implement flow variability plans. This IM would not adversely affect the volume of water available for Reclamation's Klamath Project or wildlife refuges.	Complete	Would continue	Would not continue
IM6 – Fish Disease Relationship and Control Studies	ICP	PacifiCorp has established a fund to study fish disease relationships downstream from Iron Gate Dam. PacifiCorp would consult with the Klamath River Fish Health Workgroup regarding selection, prioritization, and implementation of such studies.	Ongoing	Would continue	Would not continue
IM7 – J.C. Boyle Gravel Placement and/or Habitat Enhancement	Non-ICP	PacifiCorp would provide funding for the planning, permitting, and implementation of gravel placement or habitat enhancement projects, including related monitoring, in the Klamath River upstream of Copco No. 1 Reservoir.	Ongoing	Would not continue	Would not continue
IM8 – J.C. Boyle Bypass Barrier Removal	Non-ICP	PacifiCorp would remove the sidecast rock barrier approximately 3 miles upstream of the J.C. Boyle Powerhouse in the Bypass Reach, to improve upstream fish passage.	Complete	Completed, part of existing conditions	Completed, part of existing conditions

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	No Project Alternative	Proposed Project
IM9 – J.C. Boyle Powerhouse Gage	Non-ICP	Upon the Effective Date, PacifiCorp shall provide the U.S. Geological Survey with continued funding for the operation of the existing gage below the J.C. Boyle Powerhouse.	Ongoing	Would not continue	Would not continue
IM10 – Water Quality Conference	Non-ICP	PacifiCorp shall provide one-time funding of $100,000 to convene a basin-wide technical conference on water quality within one year from the Effective Date of the KHSA.	Complete	Completed, part of existing conditions	Completed, part of existing conditions
IM11 – Interim Water Quality Improvements	Non-ICP	PacifiCorp shall spend up to $250,000 per year to be used for studies or pilot projects developed in consultation with the Implementation Committee to improve interim water quality in the Klamath River.	Studies and pilot projects ongoing	Would not continue	Studies and pilot projects would not continue. Water Quality Improvement Project would begin[2]
IM12 – J.C. Boyle Bypass Reach and Spencer Creek Gaging	Non-ICP	PacifiCorp shall install and operate stream gages at the J.C. Boyle Bypass Reach and at Spencer Creek.	Complete	Would not continue	Would not continue
IM13 – Flow Releases and Ramp Rates	Non-ICP	PacifiCorp would maintain current operations including instream flow releases of 100 cfs from J.C. Boyle Dam to the J.C. Boyle Bypass Reach and a 9-inch per hour ramp rate below the J.C. Boyle Powerhouse prior to transfer of the J.C. Boyle facility.	Ongoing	Would continue as part of existing operations	Would not continue
IM14 – 3,000 cfs Power Generation	Non-ICP	Upon approval by Oregon Water Resources Department, PacifiCorp would continue maximum diversions of 3,000 cfs at J.C. Boyle Dam for power generation.	Ongoing	Would continue as part of existing operations	Would not continue

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	No Project Alternative	Proposed Project
IM15 – Water Quality Monitoring	Non-ICP	PacifiCorp shall fund long-term baseline water quality monitoring to support dam removal, nutrient removal, and permitting studies, and also will fund blue-green algae and blue-green algae toxin monitoring as necessary to protect public health. Funding of $500,000 shall be provided per year. The funding shall be made available beginning April 1, 2010 and annually on April 1.	Ongoing	Would not continue	Would not continue
IM16 – Water Diversions	Non-ICP	PacifiCorp shall seek to eliminate three screened diversions from Shovel (2) and Negro (1) Creeks and shall seek to modify its water rights as listed above to move the points of diversion from Shovel and Negro Creek to the mainstem Klamath River.	Not yet occurred	Would not occur	PacifiCorp would undertake separate from the Proposed Project —see Section 3.24 *Cumulative Effects*
IM17 – Fall Creek Flow Releases	Non-ICP	PacifiCorp would continue to provide a continuous flow release to the Fall Creek Bypass Reach targeted at 5 cfs.	Ongoing	Would continue as part of existing operations	Would continue as part of existing operations
IM18 – Hatchery Funding	Non-ICP	PacifiCorp shall fund 100 percent of Iron Gate Hatchery operations and maintenance necessary to fulfill annual mitigation objectives developed by the California Department of Fish and Wildlife in consultation with the National Marine Fisheries Service (NMFS) and consistent with existing FERC license requirements.	Ongoing	Percent of funding may not continue but hatchery would continue operations	Would not continue, see IM19 and IM20

Interim Measure	Interim Conservation Plan (ICP)[1]	Description	Existing Conditions	No Project Alternative	Proposed Project
IM19 – Hatchery Production Continuity	Non-ICP	PacifiCorp will begin a study to evaluate hatchery production options that do not rely on the current Iron Gate Hatchery water supply. Based on the study results, and within six months following the DRE's acceptance of the FERC surrender order, PacifiCorp will propose a post-Iron Gate Dam Mitigation Hatchery Plan (Plan) to provide continued hatchery production for eight years after the removal of Iron Gate Dam.	Ongoing	Would not continue	Would be complete
IM20 – Hatchery Funding After Removal of Iron Gate Dam	Non-ICP	After removal of Iron Gate Dam and for a period of eight years, PacifiCorp shall fund 100 percent of hatchery operations and maintenance costs necessary to fulfill annual mitigation objectives developed by CDFW in consultation with NMFS.	Not yet occurred	Would not occur	Would occur

[1] The Interim Conservation Plan refers to the plan developed by PacifiCorp through technical discussions with NMFS and USFWS regarding voluntary interim measures for the enhancement of coho salmon and suckers listed under the ESA, filed with FERC on November 25, 2008, or such plan as subsequently modified.

[2] Per the KHSA Appendix D, Non-Interim Conservation Plan Interim Measures, following the DRE's (Dam Removal Entity or KRRC) acceptance of the license surrender order, PacifiCorp shall provide funding of up to $5.4 million for implementation of projects approved by the Oregon Department of Environmental Quality (ODEQ) and the California State and Regional Water Quality Control Boards, and an additional amount of up to $560,000 per year to cover project operation and maintenance expenses related to those projects, these amounts subject to adjustment for inflation as set forth in Section 6.1.5 of the KHSA. PacifiCorp would provide funding for these nutrient reduction projects separate from the Proposed Project (see Section 3.24 *Cumulative Effects*).

4.2.1.2 Alternative Analysis Approach

As for the Proposed Project, the potential impacts of the No Project Alternative are analyzed in comparison to existing conditions. Unless otherwise indicated, the significance criteria, area of analysis, environmental setting, and impact analysis approach, including consideration of existing local policies, for all environmental resource areas under the No Project Alternative are the same as those described for the Proposed Project (see Section 3.1 *Environmental Setting Introduction* and individual resource area subsections in Section 3 *Environmental Setting, Impacts, and Mitigation Measures*). The time frame of analysis for the No Project Alternative differs from that of the Proposed Project, as described above.

4.2.2 Water Quality

As described for the Proposed Project Water Quality *Impact Analysis Approach* (Section 3.2.4), the approach to analyzing potential water quality impacts associated with the No Project Alternative involves quantitative numeric models, where possible and appropriate, and qualitative analyses otherwise. However, the time frame of the No Project Alternative is different from that of the Proposed Project. As described in Section 4.2.1.1 *Alternative Description – Foreseeable Short-term Operations*, the No Project Alternative considers reasonably foreseeable conditions over the period of 0−5 years.

Water Temperature

For the No Project Alternative, there would be no short-term sediment release due to removal of the Lower Klamath Project. As such, there would be no potential for changes in water temperature from existing conditions in the Klamath River Estuary due to sediment-related morphological changes in the estuary since sediment releases from dam removal would not occur (Potential Impact 3.2-2).

Water temperature existing conditions would not be altered by changes to the IMs implemented by PacifiCorp under the No Project Alternative (Table 2.7-19). IMs integrated into PacifiCorp's annual licenses as part of an ICP would continue implemented by PacifiCorp under the No Project Alternative, while IMs not incorporated into the ICP (non-ICP) would either cease or continue as listed in Table 2.7-19. The non-ICP IMs primarily relate to monitoring, funding, and hatcheries, so there would be no effect on water temperature from ending those IMs.

As described under the Proposed Project (Potential Impact 3.2-1), climate change would be anticipated to only significantly influence water temperature existing conditions in the long term (5+ years), so climate change is not discussed further for water temperature under the No Project Alternative. As noted in Section 4.2.1.1 *Alternative Description – Foreseeable Short-term Operations*, long-term outcomes are considered in the Proposed Project and other alternatives, thus long-term water temperature impacts are described in: Section 3.2.5.1 [*Water Quality*] *Water Temperature;* Section 4.3.2 *Water Quality*; Section 4.4.2 *Water Quality*; Section 4.5.2 *Water Quality*; Section 4.6.2 *Water Quality*; and Section 4.7.2 *Water Quality.*

Other potential impacts related to water temperature in the foreseeable short-term (0−5 years) under the No Project Alternative are discussed under a new impact heading, below.

Potential Impact 4.2.2-1 Seasonal alterations in water temperature due to continued impoundment of water in the reservoirs.

In general, the No Project Alternative would not affect the current ongoing changes to water temperature caused by the reservoirs and by dam operations, as described in Section 3.2.2.2 *Water Temperatur*e. The existing temperature conditions in the Lower Klamath Project reservoirs would continue under the No Project Alternative, including larger diel (i.e., 24-hour period) variations in summer water temperature due to hydropower peaking operations, seasonal reservoir stratification, and seasonal shifts in water temperature downstream of the reservoirs, as described under existing conditions in Section 3.2.2.2 *Water Temperature*.

Hydroelectric Reach

In the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir, daily hydropower peaking operations would continue to cause artificially high daily maximum water temperatures and daily variability in water temperatures that occur under existing conditions. In the remainder of the Hydroelectric Reach (i.e., Copco No. 1 and Iron Gate reservoirs) water temperatures would be the same as those described under the existing condition (see Section 3.2.2.2 *Water Temperature*), where spring, summer, and fall water temperatures would continue to be influenced by the thermal mass of Copco No. 1 and Iron Gate reservoirs, and the seasonal stratification patterns of the two reservoirs. It is unclear what, if any, steps could reduce the impact of the reservoirs on the thermal regime within the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam and comply with the Thermal Plan's ban on elevated temperature discharges into COLD interstate waters (Table 3.2-4). Improvements from existing conditions under the Proposed Project described in Potential Impact 3.2-1 would not occur under the No Project Alternative.

Middle and Lower Klamath River and Klamath River Estuary

The continued impoundment of water in Copco No. 1 and Iron Gate reservoirs under the No Project Alternative would maintain existing adverse late summer/fall water temperatures in the Hydroelectric Reach downstream of Copco No. 1 Reservoir and in the Middle Klamath River downstream of Iron Gate Dam (see Section 3.2.2.2 *Water Temperature*). Temperature effects of the dams do not extend downstream of the Salmon River confluence (see Section 3.2.2.2 *Water Temperature*). Implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would not significantly alter the existing conditions for water temperature downstream of Iron Gate Dam in the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment, but the additional flushing and emergency dilution releases would potentially result in a temporarily more prominent seasonal shift in water temperature downstream of Iron Gate Dam during the releases. Water temperature existing conditions downstream of Copco No. 1 and Iron Gate dams are generally warmer than expected under natural conditions during late-summer and fall and cooler than expected under natural conditions during spring and early summer (see Section 3.2.2.2 *Water Temperature*). These existing conditions could be accentuated by the additional flushing and emergency dilution releases since these flows would potentially occur from November 1 to June 15 (see Section 4.2.1.1 *Alternative Description – Summary of Available Hydrology Information for the No Project Alternative*). However, these conditions would be accentuated only if releases occurred outside of winter and only for a brief time with surface flushing flows occurring for only 72-hours once every year, deep flushing flows occurring for only 24 hours once every other year, and emergency dilutions only occurring in some years if specific disease conditions are met in the Klamath River. As such, the temporary accentuation of the existing fall or spring shifts in water temperature in the Middle Klamath River downstream of Iron Gate Dam during flushing and emergency dilution releases would result in a less than significant change to existing water temperature conditions. Therefore, there would be no change in water temperature existing conditions in the Middle and Lower Klamath River reaches downstream from the confluence with the Salmon River, including the Klamath River Estuary and the Pacific Ocean nearshore environment under the No Project Alternative.

Overall, there would be no change from existing, adverse conditions for water temperature in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, or the Pacific Ocean nearshore environment in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative and the existing, adverse conditions for water temperature would continue to cause an exceedance of water quality standards as set forth in the Thermal Plan. Thus, there would be no significant impact to water temperature under the No Project Alternative.

Significance
No significant impact

Suspended Sediments
The No Project Alternative would not release the reservoir sediment stored behind the Lower Klamath Project dams because this alternative would not remove the existing dams. Thus, there would be no short-term increase in suspended sediment concentrations (SSCs) during drawdown (Potential Impact 3.2-3) and there would be no significant impact.

IMs integrated into PacifiCorp's annual licenses as part of an ICP would continue to be implemented by PacifiCorp under the No Project Alternative, while IMs not incorporated into the ICP (non-ICP) would either cease or continue as listed in Table **2.7-19**4.2-1. The non-ICP IMs primarily relate to monitoring, funding, and hatcheries, so there would be no change from existing conditions for suspended sediments from ending those IMs. J.C. Boyle gravel placement and/or habitat enhancement (IM7) (Table 4.2-1), including gravel augmentation downstream of Iron Gate Dam (PacifiCorp 2014a), would not continue under the No Project Alternative. Thus, any incidental sediment release occurring under the existing condition as a result of this activity would cease. Because of construction management practices employed, this currently does not cause a meaningful degree of sedimentation in the river, and so ceasing this practice would be unlikely to affect suspended sediments relative to existing conditions.

As noted in Section 4.2.1.1 *[No Project Alternative] Alternative Description – Foreseeable Short-term Operations*, the long-term outcomes, including climate change and changes in algal-derived (organic) suspended material due to nutrient reduction measures in Oregon and California, are considered for the Proposed Project and other alternatives, thus the long-term suspended sediment impacts are described in: Section 3.2.5.2 [*Water Quality*] *Suspended Sediments;* Section 4.3.2 *Water Quality*; Section 4.4.2 *Water Quality*; Section 4.5.2 *Water Quality*; Section 4.6.2 *Water Quality*; and Section 4.7.2 *Water Quality.*

Other potential impacts related to suspended sediments in the foreseeable short-term (0−5 years) under the No Project Alternative are discussed under new impact headings, below.

Potential Impact 4.2.2-2 Seasonal increases in algal-derived (organic) suspended material due to continued impoundment of water in the reservoirs.

The No Project Alternative would result in no change from existing conditions with respect to interception, decomposition, retention, and/or dilution[179] of algal-derived (organic) suspended material originating from Upper Klamath Lake (in Oregon) within J.C. Boyle Reservoir and the Hydroelectric Reach to Copco No. 1 Reservoir (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). With its shallow depth and short residence time, J.C. Boyle Reservoir does not provide suitable habitat for seasonal phytoplankton (including blue-green algae) blooms (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). The No Project Alternative would continue to result in the same adverse seasonal increases in algal-derived (organic) suspended material in Copco No. 1 and Iron Gate reservoirs as existing conditions, with subsequent release of suspended material to the Middle and Lower Klamath River, and eventually the Klamath River Estuary (Section 3.2.2.3 *Suspended Sediments*), and there would be no significant impact.

Nutrient reduction measures in Oregon and California due to the Klamath TMDLs only would result in long-term changes in algal-derived (organic) suspended material, so they are considered as part of the Proposed Project and other alternatives.

<u>Significance</u>

No significant impact

Potential Impact 4.2.2-3 Increases in suspended material due to implementation of 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam.

Implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would mobilize more sand, silt, and clay sized sediment downstream of Iron Gate Dam than under the existing conditions when the releases occur since the flushing releases are designed to mobilize such sediments. There would be an increase in suspended sediment concentrations (SSCs) under flushing flows compared to existing conditions, but the increase in SSCs downstream of Iron Gate Dam would have a limited duration much less the two-weeks that would result in a significant impact. Flushing flows would only occur for 72-hours (surface flushing) or 24-hours (deep flushing), so increases in SSCs due to flushing flows are unlikely to increase SSCs above 100 milligrams per liter (mg/L) for an entire two-week period (i.e., the suspended sediment threshold of significance; see Section 3.2.3.1 *Thresholds of Significance – Suspended Sediments*). While emergency dilution releases would potentially occur for a longer period, emergency dilution flows (3,000 to 4,000 cfs) are unlikely to increase SSCs since they are below the thresholds recognized to cause transport of suspended sediment in the Klamath River downstream of Iron Gate Dam (see USBR 2012). Thus, increases in SSCs due to implementation of the flushing and emergency dilution releases would have a less than significant impact on suspended sediment concentrations under the No Project Alternative.

[179] Dilution from coldwater springs downstream of J.C. Boyle Dam.

Significance
No significant impact

Nutrients
The No Project Alternative would not release the reservoir sediment or sediment-associated nutrients stored behind the Lower Klamath Project dams because this alternative would not remove the existing dams (Potential Impact 3.2-7).

There would be no change from existing conditions for nutrients in the Klamath River under the No Project Alternative due to changes in IMs implemented since IMs integrated into PacifiCorp's annual licenses as part of an ICP would continue under the No Project Alternative and IMs ending primarily relate to monitoring, funding, and hatcheries that would not alter nutrient compared to existing conditions. There would be no change from existing conditions for nutrients under the No Project Alternative due to ceasing J.C. Boyle gravel placement and/or habitat enhancement (IM7) (Table 4.2-1), including gravel augmentation downstream of Iron Gate Dam (PacifiCorp 2014), since gravel augmentation does not alter nutrients in the Klamath River under existing conditions.

As noted in Section 4.2.1.1 *[No Project Alternative] Alternative Description – Foreseeable Short-term Operations*, the long-term outcomes, including gradual increases in nutrients and organic matter in reservoir sediments (i.e., reservoir aging [USGS 2018]) that would potentially alter nutrients in the reservoirs and the Klamath River and decreases in nutrients from implementing nutrient reduction measures in Oregon and California as part of the Klamath TMDLs, are considered in the Proposed Project and other alternatives, thus long-term nutrient impacts are described in: Section 3.2.5.3 [*Water Quality*] *Nutrients;* Section 4.3.2 *Water Quality*; Section 4.4.2 *Water Quality*; Section 4.5.2 *Water Quality*; Section 4.6.2 *Water Quality*; and Section 4.7.2 *Water Quality.*

Other potential impacts related to nutrients in the foreseeable short-term (0−5 years) under the No Project Alternative are discussed under a new impact heading, below.

Potential Impact 4.2.2-4 Annual interception and retention of nutrients and seasonal release of nutrients due to continued impoundment of waters in the reservoirs.

Hydroelectric Reach
Nutrients in the Hydroelectric Reach would be the same as existing conditions (Section 3.2.2.4 *Nutrients*) in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative since this alternative would not remove the existing dams. The No Project Alternative would continue to result in the same small annual decreases in total phosphorus (TP) and total nitrogen (TN) through the Hydroelectric Reach as occurs under existing conditions, due to settling of particulate matter and retention of associated nutrients originating from upstream reaches, including Upper Klamath Lake (in Oregon), in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs, and dilution by the coldwater springs located downstream of J.C. Boyle Reservoir (Section 3.2.2.4 *Nutrients*). Seasonal increases in TP, and to a lesser degree TN, in the Hydroelectric Reach would continue to occur under this alternative due to the release (export) of dissolved forms of phosphorus (ortho-phosphorus) and nitrogen (ammonium) from Copco No. 1 and Iron Gate reservoir sediments during summer and fall, when reservoir bottom waters are anoxic (i.e., through the process of internal nutrient loading, see Figure 3.2-2).

Middle and Lower Klamath River and Klamath River Estuary

Nutrients transport from the Hydroelectric Reach into the Klamath River downstream of Iron Gate Dam would be the same as existing conditions (Section 3.2.2.4 *Nutrients*) in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative since this alternative would not remove the existing dams. Dissolved forms of nutrients can be transported on a seasonal basis from Copco No. 1 and Iron Gate reservoirs downstream to the Middle Klamath River where they can stimulate excessive growth of periphyton (aquatic freshwater organisms attached to river bottom surfaces) (see also Section 3.4.2.2 *Periphyton*). In the downstream direction, nutrient effects of the Lower Klamath Project reservoirs diminish due to both tributary dilution and nutrient retention (see Section 3.2.2.4 *Nutrients*).

There would be no change from existing conditions for nutrients due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam under the No Project Alternative since suspended sediments transported by these releases would be primarily mineral (inorganic) sediments occurring in the Klamath River under existing conditions.

Significance

No significant impact

Dissolved Oxygen

The No Project Alternative would not release sediments stored behind the Lower Klamath Project dams because this alternative would not remove the existing dams. Thus, there would be no short-term depletion of oxygen from the river due to resuspension of unoxidized organic matter during drawdown (Potential Impact 3.2-9) and there would be no significant impact.

There would be no change from existing conditions for dissolved oxygen in the Klamath River under the No Project Alternative due to changes in IMs implemented since IMs integrated into PacifiCorp's annual licenses as part of an ICP would continue under the No Project Alternative and IMs ending primarily relate to monitoring, funding, and hatcheries that would not alter dissolved oxygen concentrations compared to existing conditions.

As noted in Section 4.2.1.1 *[No Project Alternative] Alternative Description– Foreseeable Short-term Operations*, the long-term outcomes, including climate change and variations in dissolved oxygen from implementing nutrient reduction measures in Oregon and California as part of the Klamath TMDLs, are considered in the Proposed Project and other alternatives, thus long-term dissolved oxygen impacts are described in: Section 3.2.5.4 [*Water Quality*] *Dissolved Oxygen;* Section 4.3.2 *Water Quality*; Section 4.4.2 *Water Quality*; Section 4.5.2 *Water Quality*; Section 4.6.2 *Water Quality*; and Section 4.7.2 *Water Quality.*

Other potential impacts related to dissolved oxygen in the foreseeable short-term (0−5 years) under the No Project Alternative are discussed under a new impact heading, below.

Potential Impact 4.2.2-5 Seasonal low dissolved oxygen concentrations due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

The No Project Alternative in the Klamath River would result in no change from existing, adverse conditions in the reasonably foreseeable short-term (0−5 years) with respect to large summertime variations in dissolved oxygen in the Hydroelectric Reach and dissolved oxygen concentrations in the Middle Klamath River immediately downstream of Iron Gate Reservoir that fall below the Basin Plan minimum dissolved oxygen criteria (Section 3.2.2.5 *Dissolved Oxygen*). In J.C. Boyle Reservoir, summertime variations in dissolved oxygen, especially at depth, would continue to occur and potentially release water with low dissolved oxygen concentrations to the Klamath River immediately downstream of J.C. Boyle Dam during summer/late fall when dissolved oxygen concentrations would potentially be below 5 mg/L (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.1*). The influence of J.C. Boyle Dam on dissolved oxygen concentration in the Klamath River decreases in the downstream direction as turbulent mixing and water velocities in the free-flowing river reach provides sufficient aeration under existing conditions (Appendix C – *Section C.4.1*). Due to seasonal stratification in Copco No. 1 and Iron Gate reservoirs that would occur under the No Project Alternative similar to existing conditions, adverse seasonal anoxia (0 mg/L dissolved oxygen) in reservoir bottom waters could continue to occur under this alternative, with seasonal stratification and associated anoxia typically beginning by May and lasting through October to early November (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.1*). Daily dissolved oxygen concentration variations within the Lower Klamath Project reservoirs due to phytoplankton growth in the reservoir would continue, so there would be no change for existing conditions and no significant impact on dissolved oxygen in the Hydroelectric Reach for the reasonably foreseeable short-term (0−5 years) under the No Project Alternative.

Middle and Lower Klamath River and Klamath River Estuary

Immediately downstream of Iron Gate Dam, this alternative would continue to result in low dissolved oxygen in waters released from Iron Gate Reservoir during summer/late fall months, where concentrations regularly fall below 8.0 mg/L and the current Basin Plan minimum dissolved oxygen criteria based on percent saturation[180] (see also Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*). Further downstream, the effects of the Lower Klamath Project on dissolved oxygen diminish due to natural stream re-aeration, such that effects are not generally discernable by Seiad Valley (River Mile [RM] 132.7) (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*).

Dissolved oxygen concentrations due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would be similar to existing conditions, but dissolved oxygen would likely increase immediately downstream of Iron Gate Dam in the Middle Klamath River during releases due to increased turbulent mixing and aeration under the higher flushing flows. However, these conditions would be present for only a brief time between November 1 to May 31 since surface flushing flows occur for only 72-hours once every year and deep flushing flows occur for only 24-

[180] Minimum dissolved oxygen criteria of 85 percent saturation for the period April 1 through September 30, and below the minimum criterion of 90 percent saturation for the period October 1 to March 31, for the Klamath River from Oregon-California state line (RM 214.1) to the Scott River (RM 145.1); see also Table 3.2-4.

hours once every other year. The temporary, brief increases in dissolved oxygen due to flushing flows also generally would occur before reservoirs stratify, so flushing releases would not alter the low dissolved oxygen downstream of Iron Gate Dam that occur under existing conditions during summer/late fall months. Dissolved oxygen concentrations in the Middle Klamath River under emergency dilution releases (3,000 to 4,000 cfs) would be similar to existing conditions since the increase in flow and associated mixing and aeration would be relatively small compared to existing conditions.

Increases in sediment transport due to flushing flows under this alternative would dislodge periphyton from the riverbed and decrease periphyton abundance downstream of Iron Gate Dam in the Middle Klamath River immediately after releases (see also Potential Impact 4.2.4-1). The relationship between flushing and emergency dilution releases, streambed scour and changes in periphyton abundance from the releases, and daily variations in summertime dissolved oxygen due to photosynthesis by periphyton is not fully understood, but seasonal periphyton abundance variations due to seasonal flow changes are a natural process in river systems and occur under existing conditions in the Klamath River. Periphyton naturally re-grow following high winter flows under existing conditions, so periphyton are anticipated to re-grow similarly after flushing flows. While the frequency of flushing flows (i.e., annually for surface flushing and every other year for deep flushing) and the rate of periphyton re-growth may result in a reduction in periphyton abundance downstream of Iron Gate Dam, these reductions in periphyton abundance are expected to have a less than significant impact on daily variations in summertime dissolved oxygen in the Klamath River and dissolved oxygen would be similar to existing conditions. Thus, there would be no significant impact on dissolved oxygen concentrations in the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment under the No Project Alternative due to 2017 court-ordered flushing and emergency dilution flows.

Significance

No significant impact

pH

pH existing conditions would not be altered by changes to the IMs implemented by PacifiCorp under the No Project Alternative (see Table 2.7-19). IMs integrated into PacifiCorp's annual licenses as part of an ICP would continue implemented by PacifiCorp under the No Project Alternative, while IMs not incorporated into the ICP (non-ICP) would either cease or continue as listed in Table 2.7-19. The non-ICP IMs primarily relate to monitoring, funding, and hatcheries, so there would be no change from existing adverse conditions for pH from ending those IMs.

As noted in Section 4.2.1.1 *[No Project Alternative] Alternative Description– Foreseeable Short-term Operations*, the long-term outcomes, including climate change and variations in pH from implementing nutrient reduction measures in Oregon and California as part of the Klamath TMDLs, are considered in the Proposed Project and other alternatives, thus long-term pH impacts are described in: Section 3.2.5.5 [*Water Quality*] *pH;* Section 4.3.2 *Water Quality*; Section 4.4.2 *Water Quality*; Section 4.5.2 *Water Quality*; Section 4.6.2 *Water Quality*; and Section 4.7.2 *Water Quality.*

Other potential impacts related to pH in the foreseeable short-term (0−5 years) under the No Project Alternative are discussed under a new impact heading, below.

Potential Impact 4.2.2-6 Seasonal high pH and daily pH fluctuations due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

The No Project Alternative would result in no change from the existing, adverse condition with respect to pH values that exceed the Basin Plan instantaneous maximum pH objective of 8.5 standard units (s.u.) and large daily fluctuations in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*). The reservoirs would remain in place under the No Project Alternative, so there would be no change in pH from existing, adverse conditions due to conversion of the reservoir areas to free-flowing river and there would be no significant impact on pH in the Hydroelectric Reach under the No Project Alternative.

Middle and Lower Klamath River and Klamath River Estuary

As discussed above, the No Project Alternative would continue to result in the same pH values that exceed the Basin Plan instantaneous maximum pH objective of 8.5 s.u and large daily fluctuations in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*). In the Middle and Lower Klamath River and Klamath River Estuary, pH exhibits large (0.5–1.5 pH units) daily fluctuations under existing conditions during periods of high photosynthesis and pH values also regularly exceed Basin Plan instantaneous maximum pH objective of 8.5 s.u. during late-summer and early-fall months (August–September), with the most extreme pH exceedances typically occurring from Iron Gate Dam to approximately Seiad Valley (see Section 3.2.2.6 *pH*). Under the No Project Alternative, existing conditions for pH would continue to occur for periods of high photosynthesis, particularly when large phytoplankton blooms are transported from Iron Gate Reservoir into the Middle and Lower Klamath River, with the most extreme pH exceedances typically occurring from Iron Gate Dam to approximately Seiad Valley (see Section 3.2.2.6 *pH*).

The pH in the Middle Klamath River likely would be similar to existing, adverse conditions with the 2017 court-ordered flushing and emergency dilution flows under the No Project Alternative since periphyton along the riverbed contributing to pH conditions would re-grow after reductions following releases and continue to alter pH in the river during summertime periods of high photosynthesis. Court-ordered flushing flows would mobilize sediment downstream of Iron Gate Dam between November 1 to May 31 (see Potential Impact 4.2.2-3) and dislodge periphyton from the riverbed and decrease periphyton abundance downstream of Iron Gate Dam in the Middle Klamath River immediately after releases (see Potential Impact 4.2.4-1). Emergency dilution releases (3,000 to 4,000 cfs) are below the flow recognized to mobilize sediment along the riverbed downstream of Iron Gate Dam, so there would be no change from existing conditions with respect to periphyton abundance due to these releases. While the relationship between flushing and emergency dilution releases, streambed scour and changes in periphyton abundance from the releases, and summertime increases in pH due to photosynthesis by periphyton is not fully understood, seasonal periphyton abundance variations due to seasonal flow changes are a natural process in river systems and occur under existing conditions in the Klamath River. Periphyton naturally re-grow following high winter flows under existing conditions, so periphyton are anticipated to re-grow similarly after flushing flows. While the frequency of flushing flows (i.e., annually for surface flushing and every other year for deep flushing) and the rate of periphyton re-growth may result in a reduction in periphyton abundance downstream of

Iron Gate Dam, these reductions in periphyton abundance are expected to have a less than significant impact on summertime increases in pH in the Klamath River due to periphyton photosynthesis. The Klamath River is a weakly buffered system and it is susceptible to photosynthesis-driven daily and seasonal swings in pH (see Section 3.2.2.6 *pH*), thus pH conditions in the Klamath River downstream of Iron Gate Dam are still anticipated to be similar to existing conditions even with reductions in periphyton abundance from flushing flows and there would be no significant impact to pH in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative.

Significance

No significant impact

Chlorophyll-*a* and Algal Toxins

There would be no change from existing conditions for chlorophyll-*a* and algal toxins, concentrations in the Klamath River under the No Project Alternative due to changes in IMs implemented since IMs integrated into PacifiCorp's annual licenses as part of an ICP would continue under the No Project Alternative and IMs ending primarily relate to monitoring, funding, and hatcheries that would not alter chlorophyll-*a* and algal toxins concentrations compared to existing conditions.

As noted in Section 4.2.1.1 *[No Project Alternative] Alternative Description – Foreseeable Short-term Operations*, the long-term outcomes, including climate change and decreases in chlorophyll-*a* and algal toxins from implementing nutrient reduction measures in Oregon and California as part of the Klamath TMDLs, are considered in the Proposed Project and other alternatives, thus long-term chlorophyll-*a* and algal toxin impacts are described in: Section 3.2.5.6 [*Water Quality*] *Chlorophyll-*a *and Algal Toxins;* Section 4.3.2 *Water Quality*; Section 4.4.2 *Water Quality*; Section 4.5.2 *Water Quality*; Section 4.6.2 *Water Quality*; and Section 4.7.2 *Water Quality.*

Other potential impacts related to chlorophyll-a and algal toxins in the foreseeable short-term (0−5 years) under the No Project Alternative are discussed under a new impact heading, below.

Potential Impact 4.2.2-7 Seasonal increases in chlorophyll-a and algal toxins due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

The No Project Alternative would continue to result in the same adverse, large, seasonal phytoplankton blooms, including blue-green algae, in Copco No. 1 and Iron Gate reservoirs, that occur under existing conditions and produce seasonally high chlorophyll-*a* concentrations and periodically high levels of algal toxins. In the Hydroelectric Reach, seasonal phytoplankton (including blue-green algae) blooms originating from Upper Klamath Lake (in Oregon) would still be able to enter J.C. Boyle Reservoir under this alternative, but the short residence time of this reservoir would not support substantial additional growth of algae similar to existing conditions (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). Further downstream in the Hydroelectric Reach, adverse, large, seasonal phytoplankton blooms, including blue-green algae, would continue to occur in Copco No. 1 and Iron Gate reservoirs under the No Project Alternative similar to existing conditions, resulting in chlorophyll-*a* concentrations exceeding the TMDL target of 10 ug/L during the May to October growth season, and periodically high levels of algal toxins (concentrations greater than 0.8 and/or 4 ug/L microcystin[181]) (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*). Overall, the No Project Alternative would result in no change from existing, adverse conditions and would continue to cause exceedances of water quality standards in the Hydroelectric Reach. Thus, there would be no significant impact to chlorophyll-a and algal toxins in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative in the Hydroelectric Reach.

Middle and Lower Klamath River and Klamath River Estuary

Downstream of Iron Gate Dam, chlorophyll-*a* and algal toxin trends generally would be similar to existing conditions under the No Project Alternative, with releases of chlorophyll-*a* and algal toxins (i.e., microcystin) in the Lower Klamath Project reservoirs to the Middle and Lower Klamath River, and eventually the Klamath River Estuary. Longitudinal and temporal variations in microcystin concentrations from upstream of Copco No. 1 Reservoir to Turwar indicate that Iron Gate Reservoir is the principal source of *Microcystis aeruginosa* cells to the Middle and Lower Klamath River (Otten et al. 2015) (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*). There would be no change to the habitat conditions that promote growth of *Microcystis aeruginosa* in Iron Gate Reservoir under existing conditions (see also Section 3.4.2.3 *Hydroelectric Reach*), so the export of *Microcystis aeruginosa* cells from this reservoir would also continue to occur under the No Project Alternative similar to existing conditions.

The 2017 court-ordered flushing and emergency dilution flows would result in no change from existing conditions for chlorophyll-*a* or algal toxins downstream of Iron Gate Dam, since releases would not alter conditions in Copco No. 1 or Iron Gate reservoirs that produce high chlorophyll-*a* concentrations and periodically high levels of algal toxins under existing conditions, and the court-ordered flushing and emergency dilution flows would primarily occur during winter and spring when chlorophyll-*a* and algal toxin concentrations in Iron Gate Reservoir would be low (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*). The 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would end by June 15, while monitoring data from the past five years (i.e., 2013 to 2018) indicates the abundance of blue-green algae and algal toxin concentrations (i.e., microcystin) in Iron Gate Reservoir increases above 0.8 ug/L or 4 ug/L after late June to early July (E&S Environmental Chemistry, Inc. 2013, 2014, 2015, 2016, 2018a, 2018b). Assuming blue-green algae cell counts and algal toxin concentrations from the past five years are representative of likely conditions in the reasonably foreseeable short-term (0−5 years), releases would end before elevated levels of chlorophyll-*a* or algal toxin concentrations occur in Iron Gate Reservoir, and there would be no changes from existing conditions for chlorophyll-a or algal toxin concentrations in the Middle and Lower Klamath River or the Klamath River Estuary. Overall, the No Project Alternative would result in no change from existing, adverse conditions and would continue to cause an exceedance of water quality standards in the Middle and Lower Klamath River and Klamath River Estuary. Thus, there would be no significant impact to chlorophyll-*a* and algal toxins due to flushing and

[181] Since the less than 4 ug/L criterion for microcystin in recreational waters is common to the California Klamath River TMDL, WHO, and Yurok Tribe criteria, and it is less than the Hoopa Valley Tribe recreational criterion, 4 ug/L microcystin is used as the threshold of significance for the Lower Klamath Project EIR water quality analysis. The current lowest CCHAB and Yurok Tribe posting limit for microcystin (0.8 ug/L) is also considered in the analysis although application of the lower threshold would in no case change the significance determinations in this EIR (see Section 3.2.3.1 *Thresholds of Significance – Chlorophyll-a and Algal Toxins*).

emergency dilution releases in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative in the Middle and Lower Klamath River and the Klamath River Estuary.

Significance

No significant impact

Inorganic and Organic Contaminants

There would be no change from existing conditions for inorganic and organic contaminants in the Klamath River under the No Project Alternative due to changes in IMs implemented since IMs integrated into PacifiCorp's annual licenses as part of an ICP would continue under the No Project Alternative and IMs ending primarily relate to monitoring, funding, and hatcheries that would not alter inorganic and organic contaminants in the Klamath River compared to existing conditions.

Increases in human or freshwater aquatic species' exposure to inorganic and organic contaminants associated with sediment release under the Proposed Project (Potential Impacts 3.2-14 and 3.2-15) would not occur because the dams and sediment deposits would remain in place. Herbicide application during restoration of the former reservoir areas would not occur, as the reservoirs would remain in place (Potential Impact 3.2-16).

There would be no change from existing conditions in the reasonably foreseeable short-term (0−5 years) with respect to changes in Iron Gate Hatchery operations on Klamath River water quality since Iron Gate Hatchery would continue existing operations (Potential Impact 3.2-17). Fall Creek Hatchery would not be reopened under this alternative and thus there would be no effects of hatchery discharges on water quality and thus no significant impact (Potential Impact 3.2-17). There would be no significant impacts on water quality from short-term construction activities on Parcel B lands since land transfer would not occur (Potential Impact 3.2-18).

As noted in Section 4.2.1.1 *[No Project Alternative] Alternative Description– Foreseeable Short-term Operations*, the long-term outcomes are considered in the Proposed Project and other alternatives, thus inorganic and organic contaminants impacts are described in: Section 3.2.5.7 *[Water Quality] Inorganic and Organic Contaminants;* Section 4.3.2 *Water Quality*; Section 4.4.2 *Water Quality*; Section 4.5.2 *Water Quality*; Section 4.6.2 *Water Quality*; and Section 4.7.2 *Water Quality.*

Other potential impacts related to inorganic and organic contaminants in the foreseeable short-term (0−5 years) under the No Project Alternative are discussed under a new impact heading, below.

Potential Impact 4.2.2-8 Human and freshwater aquatic species' exposure to inorganic and organic contaminants due to continued impoundment of water in the reservoirs.

The No Project Alternative would continue the existing condition with respect to human or freshwater aquatic species exposure to inorganic and organic contaminants (Section 3.2.2.7 *Inorganic and Organic Contaminants*). Implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would have no effect on exposure pathways for inorganic and organic contaminants because the flow changes would not alter the Lower Klamath Project reservoir sediment deposits nor would they alter physical, chemical, or biological conditions within the river or reservoir reaches that would change the potential for exposure to inorganic or organic contaminants compared with existing conditions. Overall, there would be no change in human or freshwater aquatic species' exposure to inorganic and organic contaminants relative to existing conditions, thus there would be no significant impact due to inorganic or organic contaminants in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative in the Hydroelectric Reach, the Middle and Lower Klamath River and the Klamath River Estuary.

Significance

No significant impact

4.2.3 Aquatic Resources

4.2.3.1 Key Ecological Attributes

Suspended Sediment

As described in Section 3.3.4.1 *Suspended Sediment*, the potential effects of suspended sediment on anadromous fish species were assessed using SRH-1D (Huang and Greimann 2010, as summarized in USBR 2012). Suspended sediment effects under the No Project Alternative are described in detail in Appendix E and summarized below. Under the No Project Alternative, suspended sediment would be the same as under existing conditions. Most suspended sediment is supplied by tributaries; Iron Gate Dam currently interrupts both fine and coarse sediment transport, so suspended sediment generally increases in a downstream direction. The Lower Klamath River downstream from the Trinity River confluence (RM 43.3) to the estuary mouth (RM 0) is listed as sediment impaired under Section 303(d) of the Clean Water Act (CWA).

Daily durations of SSC concentrations were modeled assuming the No Project Alternative occurred within each of the 49 years in the available hydrology record (1961–2009).

For each simulation year in the 49-year record, the duration of SSCs over a given threshold was calculated for each species and life-history stage (e.g., duration of SSC over 1,000 mg/L during spring-run Chinook salmon adult upstream migration). Species selected for the suspended sediment analysis included Chinook salmon (fall- and spring-runs), coho salmon, steelhead (summer and fall/winter runs), Pacific lamprey, and green sturgeon. The results of modeling all potential years were summarized for each life-stage of each species assessed. This information was used assess the impacts of SSCs on fish under a No Project Alternative, based on the concentration and duration of exposure using an approach described by Newcombe and Jensen's (1996). As described in Appendix E, Newcombe and Jensen (1996) reviewed and synthesized 80 published reports of fish responses to suspended sediment in laboratories, streams, and estuaries and established a set of equations to calculate "severity of ill effect" (SEV) indices. A suite of six equations were developed that evaluate the effects of suspended sediment (at various concentrations, durations of exposure, and particle sizes) on various taxonomic groups of fishes and life stages of species within those groups.

Because the suspended sediment varies with hydrology, and in order to account for (and compare) the range of results and impacts that might occur under the No Project Alternative, three scenarios were analyzed for the No Project Alternative with the goal of predicting the potential impacts to fish that has either a 90 percent (mild conditions for fish), 50 percent (median conditions for fish) or 10 percent (extreme conditions for fish) probability of occurring, defined as follows:

- **Median conditions for fish:** This scenario represents the conditions that most often occur for each species and life stage—that is to say, SSCs and durations with a 50 percent exceedance probability for the mainstem Klamath River downstream from Iron Gate Dam. This means that under existing conditions there is an equal chance that the SSCs will be higher or lower than described. Exceedance probabilities were based on modeling SSCs for all water years from 1961 to 2009 with facilities in place.
- **Mild conditions for fish:** This scenario represents mild conditions of the potential sediment-related impacts to a species and life stage. It uses suspended sediment concentrations and durations with a 90 percent exceedance probability. This means that under these rare mild conditions for fish scenario the probability of these concentrations and durations being equal to or less than this level for each assessed species and life-stage in any one year is 10 percent, and the probability of them being exceeded is 90 percent.
- **Extreme conditions for fish:** This scenario represents extreme conditions for fish from potential sediment-related impacts. It uses SSCs and durations with a 10 percent exceedance probability. This means that under these rare extreme conditions for fish scenario the probability of these concentrations and durations being equal to or greater than this level for each assessed species and life-stage in any one year is 10 percent, and the probability of them being less than this level is 90 percent.

Under mild, median, or extreme conditions for fish, the magnitude and duration of the SSCs modeled for the No Project Alternative are expected to cause major stress to migrating adult and juvenile salmonids (SEV greater than 8) primarily during winter (see Appendix E for detailed analysis).

Bed Elevation and Grain Size Distribution

Under the No Project Alternative, reasonably foreseeable short-term (0−5 years) bed elevation and grain size distribution conditions downstream of Iron Gate Dam are expected to remain the same as existing conditions, since Lower Klamath Project dams will continue to trap sediment, as described in Appendix F and summarized in Section 3.11.2.2 *Geomorphology*.

Water Quality

Upper Klamath River—Hydroelectric Reach

Under the No Project Alternative, continued high rates of algal photosynthesis in the two largest reservoirs in the Hydroelectric Reach (Copco No. 1 and Iron Gate) would result in dissolved oxygen and pH values that would not consistently meet California Basin Plan water quality objectives (see Section 3.2 *Water Quality*). The bottom waters (i.e., hypolimnion) of Copco No. 1 and Iron Gate reservoirs would continue to have very low dissolved oxygen levels (< 1 mg/L to 5 mg/L) during summer stratification periods. Based on existing conditions, pH during summer through fall in Copco No. 1 and Iron Gate reservoirs would continue to range from just above neutral (7) to greater than 9 (slightly basic), with the highest values occurring during algal blooms. The ongoing presence of Copco No. 1 and Iron Gate reservoirs, the two largest reservoirs in the Hydroelectric Reach, would also continue to provide the conditions necessary for large seasonal blue-green algae blooms, including *Microcystis aeruginosa*, which can produce a toxin and contribute to reduced health and increased mortality rates for fish and other aquatic resources both within the reservoirs and in areas downstream.

Middle and Lower Klamath River

Ongoing efforts to improve water quality conditions in this reach are underway through the TMDL process and considerable efforts to improve habitat are also underway (Hamilton et al. 2011). Once fully implemented, these efforts could reduce existing water quality degradation that contribute to reduced health and increased mortality rates for aquatic resources (described below) to some extent, but this process would be slower and more challenging than with the dams removed (Section 4.2.1 *Introduction*). In the interim, water quality conditions that may reduce survival of fish and other aquatic resources would persist downstream from Iron Gate Dam.

Modeling conducted for development of the California Klamath River TMDL indicates that under the No Project Alternative, dissolved oxygen concentrations immediately downstream from Iron Gate Dam would not meet the North Coast Basin Plan water quality objective of 85 percent saturation during August–September and the 90 percent saturation objective from October–November (Section 3.2.2.5 *Dissolved Oxygen*, Figure 3.2-20). Further downstream, near the confluence with the Shasta River, dissolved oxygen concentrations under the No Project Alternative would not meet the 90 percent saturation objective from October–November (Section 3.2.2.5 *Dissolved Oxygen*, Figure 3.2-21). In the Klamath River at Seiad Valley, concentrations would be mostly in compliance, with the exception of modeled values in November that would not meet the 90 percent saturation objective (Section 3.2.2.5 *Dissolved Oxygen*, Figure 3.2-21). By the Salmon River (RM 66) confluence, with full attainment of TMDL allocations, predicted dissolved oxygen concentrations would remain at or above the 85 percent saturation objective (as well as the 90 percent saturation objective, where applicable), meeting the Water Quality Control Plan for the North Coast Region (California Basin Plan) requirements.

Under the No Project Alternative, continued high rates of algal photosynthesis in the reservoirs would result in high pH values in the Lower Klamath River downstream from Iron Gate Dam. Under the No Project Alternative, pH would continue to be elevated with high diurnal variability during summer and early fall months.

The overall anticipated effect on dissolved oxygen in the Lower Klamath River under the No Project Alternative would be an increasing trend toward compliance with water quality objectives and support of designated beneficial uses, but with possible continued seasonally low dissolved oxygen downstream from Iron Gate Dam. The seasonally low dissolved oxygen levels in this reach would not consistently meet California Basin Plan and Hoopa Valley Tribe water quality objectives. The No Project Alternative would continue to periodically result in dissolved oxygen levels that may be deleterious to aquatic resources downstream from Iron Gate Dam, but adverse effects would be similar to or less than under existing conditions.

Water Temperature

Upper Klamath River—Hydroelectric Reach

Under the No Project Alternative, the effects of ongoing and future upstream water quality improvements under the TMDLs would improve water temperatures downstream of Keno Dam, as described in Section 3.2.2.2 *Water Temperature*. The river's thermal regime downstream from the reservoirs would continue to be out of phase with the natural temperature regime (Hamilton et al. 2011). Unnatural temperature fluctuations would continue downstream from the J.C. Boyle Bypass Reach, from the mixture of cold-water inflow from Big Springs and the warmer water discharge from the J.C. Boyle Powerhouse (Hamilton et al. 2011).

Middle and Lower Klamath River

Under the No Project Alternative, the Lower Klamath River downstream from Iron Gate Dam would continue to have elevated water temperatures in the summer and fall in the near term. The reservoirs have the effect of changing the timing and magnitude of the thermal regime by increasing water temperatures in the fall as a result of the increased hydraulic residence time and thermal mass (Bartholow et al. 2005). Bartholow et al. (2005) and PacifiCorp (2004b) showed that the reservoirs delay seasonal thermal signatures by 18 days.

Dams would continue to increase late summer and early fall water temperatures in the Klamath River downstream from Iron Gate Dam (3.2.2.2 *Water Temperature*). Under the No Project Alternative in the fall, the dams would not decrease temperatures of water that is transported downstream from Upper Klamath Lake. This is due to the fact that powerhouse withdrawals for Copco No. 1 and Iron Gate Dams are primarily from the epilimnion (surface waters) (see Appendix C, Section C.1.1.4) which is heated by ambient air under existing reservoir operations. Unlike Shasta Dam or other deep reservoirs that support downstream tailwater fisheries by release of cold water from low level outlets, the location of dam outlets in the Klamath River cannot be adjusted to access large volumes of cold water in the bottom of the reservoirs (hypolimnion).

Under this alternative, the current phase shift and lack of temporal temperature diversity in the middle and lower Klamath River would persist, including current warm temperatures in late summer and fall (Hamilton et al. 2011). Juvenile and adult salmonids migrating in late summer and fall would continue to experience warm temperatures that could be deleterious to health and survival, including increased risk of disease, and high rates of delayed spawning and pre-spawn mortality (Hetrick et al. 2009). This phase shift and the resulting warm fall temperatures results in delayed adult upstream salmonid migration, which is believed to delay fall spawning (Dunsmore and Huntington 2006). Under the No Project Alternative, the existing cold-water temperatures in spring would likely continue to delay emergence and reduce growth rates of juveniles (Hardy et al. 2006).

In addition, the decrease in diel temperature variation compared with historical conditions is deleterious for salmonids. Historically, diel temperature variation would result in regular nighttime cooling of water, offering daily relief with significant bioenergetic benefits that helped fish persist under marginal water temperature conditions (NRC 2004). Under the No Project Alternative, the current lack of diel temperature variation would continue to reduce the value of thermal refuge habitat (Dunsmoor and Huntington 2006) and reduce the suitability of rearing habitat in the mainstem Klamath River (NRC 2004).

In addition to direct thermal stress, the potential for continued elevated water temperatures in the late summer/fall under the No Project Alternative could result in indirect stressors on salmonids including an increased intensity and duration of algal blooms, decreased dissolved oxygen levels, and conditions conducive to disease

(Bartholomew and Foott 2010). These effects would adversely impact cold-water fish communities and would be deleterious to warm-water fish communities as well.

Klamath River Estuary and Pacific Ocean Nearshore Environment
Under the No Project Alternative, water temperatures in the Klamath River Estuary and Pacific Ocean would remain similar to the existing conditions and climate change would continue to play a role in future temperatures as described above.

Fish Disease and Parasites
As described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Fish Disease and Parasites]*, The ongoing presence of the dams under the No Project Alternative would continue to contribute to the static flows, immobile substrate, seasonally warm water temperatures, and planktonic food sources in the mainstem Klamath River that are favorable for polychaetes and for *C. shasta* and *P. minibicornis* (Hetrick et al. 2009). Salmon carcasses would continue to concentrate downstream from Iron Gate Dam, where the polychaete hosts are abundant, facilitating the cross infection between the fish and the polychaetes. Under the No Project Alternative, mortality associated with *C. shasta* and *P. minibicornis* would be expected to worsen or remain similar to existing conditions. These conditions would continue to adversely affect salmon outmigrating from tributaries downstream from Iron Gate Dam, including those from the Shasta and Scott rivers. However, additional winter-spring surface flushing flows and deep flushing flow requirements outlined in *Measures to Reduce Ceratanova Shasta Infection of Klamath River Salmonids: A Guidance Document* and U.S. District Court Filing 111 (U.S. District Court 2017a–c; described in Section 4.2.3) is predicted to help reduce juvenile salmon disease below Iron Gate Dam. As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing flows were required in 2017 and 2018, with the intent of reducing disease in the Lower Klamath River by mobilizing bedload sediments. In addition, court ordered emergency dilution flows were required in 2018. As described in Section 3.1.6, the 2017 court-ordered flows include a requirement to ensure that certain high flows are reached each winter, and also include an emergency dilution requirement if juvenile fish disease reaches high levels in the infection nidus. The emergency dilution flows were used in 2018. While the flushing flows have not been occurring over a long enough time to allow collection of enough data on the efficacy of the flushing flows, the necessity to use the emergency dilution flows in 2018 suggest that the addition of the flushing flows is insufficient on its own to resolve the issue of fish disease downstream of Iron Gate Dam. Therefore, the No Project Alternative would result in continued substantial deleterious effects on salmon because of fish disease and parasites.

Algal Toxins
Upper Klamath River - Hydroelectric Reach
Continued impoundment of water at the Lower Klamath Project reservoirs under the No Project Alternative would continue to support suitable growth conditions for toxin-producing nuisance algal species such as *Microcystis aeruginosa* in Copco No. 1 and Iron Gate reservoirs, resulting in high seasonal concentrations of algal toxins in the Hydroelectric Reach. This would result in continued bioaccumulation of microcystin in fish tissue for species in the Hydroelectric Reach and could be deleterious to fish health (Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*).

Middle and Lower Klamath River

Continued impoundment of water within the Lower Klamath Project reservoirs under the No Project Alternative would continue to support suitable growth conditions for toxin-producing nuisance algal species such as *Microcystis aeruginosa* in Copco No. 1 and Iron Gate reservoirs and subsequent transport of high seasonal concentrations of algal toxins to the Klamath River downstream from Iron Gate Dam. This would also support continued bioaccumulation of microcystin in fish and muscle tissue for species downstream from the dam (3.2.2.7 *Chlorophyll-a and Algal Toxins*).

Aquatic Habitat and Instream Flows

Under the No Project Alternative, hydrology and aquatic habitat of the Klamath River from its headwaters to the estuary would generally remain the same as under existing conditions. However, additional winter-spring surface flushing flows and deep flushing flow requirements outlined in *Measures to Reduce Ceratanova Shasta Infection of Klamath River Salmonids: A Guidance Document* and U.S. District Court Filing 111 (U.S. District Court 2017a–c; described in Section 4.2.3) is predicted to help reduce juvenile salmon disease below Iron Gate Dam.

Activities currently underway to improve aquatic habitat and recover salmonid populations within the Klamath Basin would continue at their current levels. Recovery actions to improve aquatic habitat under the Klamath River Coho Salmon Recovery Plan (NMFS 2014) would continue, depending on available funding. These actions are anticipated to improve aquatic habitat conditions over time relative to current conditions within the areas that anadromous fish currently have access to. However, anadromous fish would continue to be blocked by Lower Klamath Project dams from access to a substantial quantity of historical habitat (described in Section 3.3.5.8 *Aquatic Habitat*).

4.2.3.2 Aquatic Resource Potential Impacts, Impacts, and Mitigation

Potential Impact 4.2.3-1 Effects on coho salmon critical habitat quality and quantity due to continued operations of the Lower Klamath Project.

In the short term, under the No Project Alternative, habitat conditions that support Primary Constituent Elements (PCEs) of designated critical habitat for coho salmon would continue to be impaired (NMFS 1999, 2010). Spawning habitat would continue to be impaired by sediment and instream flows within tributary streams, with little occurrence of mainstem spawning. Rearing habitat would continue to be impaired as result of habitat degradation, high water temperatures, and disease within tributaries and the mainstem. Flows would continue to be regulated by the existing 2013 BiOp, but they also would include the winter-spring surface and deep flushing flows as well as emergency dilution flow requirements (see Section 4.2.1.1 *[Alternative Description] Summary of Available Hydrology Information for the No Project Alternative*). In general, flows that support PCEs would continue to be depleted, both within tributaries and within the mainstem Klamath River, similar to existing conditions. While the quality of PCEs would likely improve gradually over time through the actions undertaken under the Klamath River Coho Salmon Recovery Plan (NMFS 2014), potential variations in the implementation schedule for recovery actions, and the time until recovery actions have a measurable effect, means that in the short term, recovery actions would not be likely to improve PCE's. Additionally, in the short term under the No Project Alternative, coho salmon access to upstream tributaries such as Jenny Creek, Fall Creek, and Shovel Creek would remain inaccessible by Lower Klamath Project facilities. Overall, under the

No Project Alternative, there would be no change from existing adverse conditions for coho salmon critical habitat in the reasonably foreseeable short-term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-2 Effects on Southern Resident Killer Whale critical habitat quality due to alterations to salmon populations due to continued operations of the Lower Klamath Project.

The Klamath River may affect PCEs of critical habitat for Southern Resident Killer Whales through its potential contribution of Chinook salmon to the food supply for Southern Resident Killer Whales, the survival and fecundity of which appears dependent upon the abundance of this species (Ward et al. 2009, Ford et al. 2009). However, data on the Southern Resident Killer Whale diet indicate that based on the migratory range and behavior of the population, the Klamath River salmon are anticipated to provide less than one percent of the diet of Southern Resident Killer Whales in most months under current and future conditions. While Southern Resident Killer Whales have been shown to consume Klamath River Chinook Salmon, the Klamath River is considered by NMFS and WDFW tenth out of the top ten priority Chinook Salmon populations for Southern Resident Killer Whales (NMFS 2018b, NMFS and WDFW 2018). Under the No Project Alternative, there would be no change in Klamath-origin Chinook salmon as compared to existing conditions, and therefore no significant impact.

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-3 Effects on eulachon critical habitat quality due to continued operations of the Lower Klamath Project.

Under the No Project Alternative, there are no major actions that are likely to alter PCEs of critical habitat for eulachon in the Klamath River Estuary. In the reasonably foreseeable short-term (0−5 years), there would be no change from existing conditions for eulachon critical habitat, and therefore no significant impact.

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-4 Effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.

Under the No Project Alternative, EFH for Chinook and coho salmon would be expected to remain similar to current conditions. Access to habitat would be limited to current levels. Conditions under the No Project Alternative would continue to contribute to elevated concentrations of disease parasites and would provide the conditions required for the cross infection of fish and polychaetes (Hetrick et al. 2009, Hamilton et al. 2011). These interacting factors could decrease the viability of Chinook and coho salmon populations in the future (Hetrick et al. 2009, Hamilton et al. 2011). Under the No Project Alternative, there would be no change from existing adverse conditions for Chinook and coho salmon EFH in the reasonably foreseeable short-term (0−5 years).

Significance
No change from existing adverse conditions in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-5 Effects on groundfish Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.
Under the No Project Alternative, sediment and habitat conditions in the estuary are not substantially altered by the Lower Klamath Project, and nearshore ocean would remain the same as they are under existing conditions. Under the No Project Alternative, there would be no change from existing conditions for groundfish EFH in the reasonably foreseeable short-term (0−5 years), and therefore no significant impact.

Significance
No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-6 Effects on pelagic fish Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.
Under the No Project Alternative, sediment and habitat conditions in the estuary and nearshore ocean would not be altered by the Lower Klamath Project, and they would continue to be the same as they are under existing conditions. Under the No Project Alternative, there would be no change from existing conditions for pelagic fish EFH in the reasonably foreseeable short-term (0−5 years), and therefore no significant impact.

Significance
No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-7 Effects on the fall-run Chinook salmon population due to continued operations of the Lower Klamath Project.
To help determine if the Proposed Project would advance restoration of the salmonid fisheries of the Klamath Basin, a Chinook Salmon Expert Panel was convened to attempt to answer specific questions that had been formulated by the project stakeholders to assist with assessing the effects of the Proposed Project compared with existing conditions (Goodman et al. 2011). In response to comments the Panel stated with certainty that under the No Project Alternative, fall-run Chinook salmon within the Klamath River will continue to decline[182]. However, as described in detail in Section 3.3.2.1 *Aquatic Species [Chinook salmon]*, although abundances are low compared to historical numbers (Table 3.3-2), in a recent review of the population status of Chinook salmon, the BRT (Williams et al. 2011) concluded that the current Klamath Basin population (which includes hatchery fish) appears to have been fairly stable for the past 30 years and is not currently in decline.

As described in Section 3.2.2 *Water Temperature*, under the No Project Alternative, the thermal regimes downstream from Iron Gate Dam would continue to be altered as a result of the Lower Klamath Project reservoirs and operations, particularly retention time of water in the reservoirs. Under existing conditions maximum temperatures in the Klamath River downstream from Iron Gate Dam to the Klamath River Estuary regularly exceed the range of chronic effects temperature thresholds (55.4–68°F) for full salmonid support in California (North Coast Regional Board 2010, Sinnott 2010a, 2011a, 2012a; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Hanington

[182] Page 69 of Appendix C of the July 20, 2011 Addendum to Goodman et al. 2011.

2013; Hanington and Ellien 2013) (see Appendix C for more detail). These detrimental temperature exceedances would continue under the No Project Alternative.

Under the No Project Alternative, Iron Gate Dam would continue to block fall-run Chinook salmon access to hundreds of miles of historical habitat, which used to extend upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005, Hamilton et al. 2016). This includes around 76 miles of potential habitat within the Lower Klamath Project, based on approximately 54 miles of potential anadromous fish (steelhead) habitat in the Project Reach (NMFS 2006a, DOI 2007)[183], reduced in consideration of the more limited distribution of Chinook salmon relative to steelhead (DOI 2007), and including over 22 miles inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009). The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009). The consequences of this ongoing loss of habitat to the population could include reduced resilience to recover from catastrophic disturbances of natural or anthropogenic origin, such as wildfire or chemical spills. Under the No Project Alternative, access to cold water habitat would continue to be severely limited, reducing opportunities for the fall-run Chinook salmon of all life stages to access refuge habitat that would increase resiliency of the population to disturbance. Under the No Project Alternative, the system of reservoirs and dams in the hydroelectric reach would continue to create conditions conducive to the spread of parasites among the fall-run Chinook salmon population downstream from Iron Gate Dam, especially where adults (and carcasses) tend to congregate in high numbers, just downstream from Iron Gate Dam (Stocking and Bartholomew 2007, Bartholomew and Foott 2010), but also in other locations further downstream. Additional factors related to the Lower Klamath Project would continue to exacerbate the risk of disease downstream from Iron Gate Dam, including increased water temperatures and dampened flow and thermal variability, reduced dissolved oxygen concentrations, loss of sediment transport through the reach due to capture of sediment by the dams, and reservoirs contributing plankton to the filter-feeding polychaete hosts of the myxozoan parasites (as discussed above in Section 4.2.3.1 *Key Ecological Attributes [Fish Disease and Parasites]*). Under the No Project Alternative, downstream-migrating juvenile Chinook salmon may continue to have high disease infection rates (Bartholomew and Foott 2010) during summer months in some years. Heavy parasite loads may increase disease-related mortality in outmigrant smolts, particularly when water temperatures are high, or may reduce ocean survival by affecting growth or fitness (Scheuerell et al. 2009).

However, additional winter-spring surface flushing flows and deep flushing flow requirements outlined in *Measures to Reduce Ceratanova Shasta Infection of Klamath River Salmonids: A Guidance Document* and U.S. District Court Filing 111 (U.S. District Court 2017a–c; described in Section 4.2.3) is predicted to help reduce juvenile salmon disease below Iron Gate Dam. As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing flows were required in 2017 and 2018, with the intent of reducing disease in the Lower Klamath River by mobilizing bedload sediments. In addition, court ordered emergency dilution flows were required in 2018. As described in Section 3.1.6, the 2017 court-ordered flows include a requirement to ensure that certain high flows are reached each winter, and also include an emergency dilution requirement if juvenile fish disease

[183] This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

reaches high levels in the infection nidus. The emergency dilution flows were used in 2018. While the flushing flows have not been occurring over a long enough time to allow collection of enough data on the efficacy of the flushing flows, the necessity to use the emergency dilution flows in 2018 suggest that the addition of the flushing flows is insufficient on its own to resolve the issue of fish disease downstream of Iron Gate Dam. Therefore, the No Project Alternative would result in continued substantial deleterious effects on fall-run Chinook salmon because of fish disease and parasites.

Effects of suspended sediment on fall-run Chinook salmon under the No Project Alternative and existing conditions are described in Appendix E.3.1.1. Overall, fall-run Chinook salmon use the mainstem Klamath River for spawning, rearing, and as a migratory corridor. Although SSCs under existing conditions and the No Project Alternative are relatively high in the mainstem downstream from Orleans, and even more so downstream from the Trinity River (State Water Resources Control Board 2006, North Coast Regional Board 2010) (Appendix E and Section 3.2.2.3 *Suspended Sediments*), they are relatively low in the reach downstream from Iron Gate Dam where most mainstem spawning occurs. Suspended sediment concentrations and durations during upstream and downstream migration, even under extreme conditions for fish, are low enough that they have limited effects on fish, although physiological stress and reduced growth rates are possible. In general, fall-run Chinook salmon under the No Project Alternative would be relatively unaffected by SSCs, because smolt outmigration primarily occurs when SSCs are naturally low (similar to existing conditions).

Under the No Project Alternative, ongoing hatchery operations would continue to mitigate for habitat lost due to construction of Iron Gate Dam by releasing millions of juvenile and yearling Chinook salmon annually. These fish may compete with the progeny of natural-origin fish for food and other limited resources, such as thermal refugia, as described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Fish Hatcheries]*. In addition, hatchery releases can increase disease infection rates through crowding and, where mortality occurs, concentrated release of myxospores on top of the area of highest polychaete densities. Data from Ackerman et al. (2006) indicate that substantial straying of Iron Gate Hatchery fish may be occurring into important tributaries of the Middle Klamath River. Straying has the potential to reduce the reproductive success of natural salmonid populations (Mclean et al. 2003, Chilcote 2003, Araki et al. 2007) and negatively affect the diversity of the populations via outbreeding depression[184] (Reisenbichler and Rubin 1999).

Under the No Project Alternative, the interruption of sediment transport processes by the dams would continue, reducing spawning gravel supply to downstream reaches and changing the dynamics of channel morphology and riparian vegetation communities that create and maintain rearing habitats for fry and juvenile fall-run Chinook salmon. Lack of sediment transport is also likely to be contributing to the high densities of polychaetes downstream from Iron Gate Dam that host salmonid parasites, through reduction of scour that would otherwise help limit periphyton growth (FERC 2007, Hetrick et al. 2009). Under the No Project Alternative, there would be no change from existing conditions for fall-run Chinook salmon in the reasonably foreseeable short-term (0−5 years).

[184] Outbreeding depression is the displacement of locally adapted genes in a wild population.

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-8 Effects on the spring-run Chinook salmon population due to continued operations of the Lower Klamath Project.

In a recent review of the population status of Chinook salmon, the Biological Review Team (BRT) (Williams et al. 2011) concluded that the current Chinook population (which includes hatchery fish) appears to have been fairly stable for the past 30 years and is not currently in decline, despite dramatic reductions in comparison to historical abundance (Table 3.3-2). However, the BRT was concerned about the relatively few populations of spring-run Chinook salmon in the Upper Klamath Trinity River ESU and the low numbers of spawners within those populations (Williams et al. 2011).

Under the No Project Alternative, poor water quality conditions caused partly by nutrient enrichment through release of blue-green algae from Lower Klamath Project reservoirs, during spring-run Chinook salmon upstream and downstream migration may cause high stress to adults and juveniles. Water quality in the mainstem Klamath River downstream from Iron Gate Dam is adversely affected by Lower Klamath Project facilities (Section 3.2.2.2 *Water Temperature*) including altered seasonal water temperature patterns, low dissolved oxygen, and increased nutrient input, as well occasional blooms of the toxic blue-green algae *Microcystis aeruginosa*. Although water quality tends to improve downstream of Iron Gate Dam to the Salmon River (the current upstream extent of spring-run Chinook distribution in the Klamath River), the effect of water quality alterations caused by Lower Klamath Project facilities is that conditions (especially water temperature and dissolved oxygen) during much of the summer are critically stressful for spring-run Chinook salmon that are present during the period June through September. Under existing conditions maximum temperatures in the Klamath River downstream from Iron Gate Dam to the Klamath River Estuary regularly exceed the range of chronic effects temperature thresholds (55.4–68°F) for full salmonid support in California (North Coast Regional Board 2010, Sinnott 2010a, 2011a, 2012a; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Hanington 2013; Hanington and Ellien 2013) (see Appendix C for more detail). These detrimental temperature exceedances would continue under the No Project Alternative. Spring Chinook salmon that are stressed by high temperatures, whether adults or juveniles, likely have lower survival rates, especially when challenged by additional water quality factors, such as low dissolved oxygen, the presence of toxic blue-green algae (*Microcystis aeruginosa*) and fish diseases, and high pH and un-ionized ammonia (3.2.2.6 *pH*). Under the No Project Alternative, downstream-migrating juvenile Chinook salmon may continue to have high disease infection rates (Bartholomew and Foott 2010) during summer months in some years. Heavy parasite loads may increase disease-related mortality in outmigrant smolts, particularly when water temperatures are high, or may reduce ocean survival by affecting growth or fitness (Scheuerell et al. 2009).

However, additional winter-spring surface flushing flows and deep flushing flow requirements outlined in *Measures to Reduce Ceratanova Shasta Infection of Klamath River Salmonids: A Guidance Document* and U.S. District Court Filing 111 (U.S. District Court 2017a–c; described in Section 4.2.3) is predicted to help reduce juvenile salmon disease below Iron Gate Dam. As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing flows were required in 2017 and 2018, with the intent of reducing disease in the Lower Klamath River by mobilizing bedload sediments. In addition, court ordered emergency dilution flows were required in 2018. As described in Section 3.1.6, the 2017 court-ordered flows include a requirement to ensure that certain high flows are reached each winter, and also include an emergency dilution requirement if juvenile fish disease reaches high levels in the infection nidus. The emergency dilution flows were used in 2018. While the flushing flows have not been occurring over a long enough time to allow collection of enough data on the efficacy of the flushing flows, the necessity to use the emergency dilution flows in 2018 suggest that the addition of the flushing flows is insufficient on its own to resolve the issue of fish disease downstream of Iron Gate Dam. Therefore, the No Project Alternative would result in continued substantial deleterious effects on spring-run Chinook salmon because of fish disease and parasites.

Under the No Project Alternative high water temperatures during summer may also reduce the growth of juvenile spring-run Chinook salmon juveniles that are rearing and migrating downstream to the ocean due to greater metabolic requirements. Because size is correlated with ocean survival (Scheuerell et al. 2009), this could lead to reduced smolt survival and subsequently, reduced escapement under the No Project Alternative. Finally, high temperatures can selectively reduce the survival of fish expressing the life history of migrating later in the summer (the "summer-run"), thus reducing genetic and life-history diversity. High water temperatures likely limit adult holding and summer rearing habitat for spring-run Chinook salmon in the main spawning tributaries, the Salmon and Trinity Rivers, which would likely reduce overall production under the No Project Alternative. Low flows in dry years can cause migration barriers to form, reducing habitat available to spawning and rearing fish.

Under the No Project Alternative, Iron Gate Dam would continue to block spring-run Chinook salmon access to their historical habitat, which used to extend upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005). This includes around 76 miles of potential habitat within the Lower Klamath Project, based on approximately 54 miles of potential anadromous fish (steelhead) habitat in the Project Reach (NMFS 2006a, DOI 2007)[185], reduced in consideration of the more limited distribution of Chinook salmon relative to steelhead (DOI 2007), and including over 22 miles inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009). The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009). In addition, access would continue to be blocked to hundreds of miles of habitat upstream of J.C. Boyle Reservoir (Hamilton et al. 2005). The consequences of ongoing blockage of Spring-run Chinook habitat under the No Project Alternative could include reduced resilience to Spring-run Chinook population for recovery from catastrophic disturbances of natural or anthropogenic origin, such as wildfire or chemical spills. Because areas upstream of Iron Gate Dam include cold-water refugia, opportunities for the population to adapt to changing climate are reduced, whether these changes are a result of short- or long-term cycles or trends.

Effects of suspended sediment on spring-run Chinook salmon under the No Project Alternative and existing conditions are described in Appendix E.3.1.2. Overall, spring-run Chinook salmon mostly use the mainstem Klamath River as a migratory corridor during adult migration, and downstream smolt migration. Although suspended sediment under existing conditions is relatively high in the mainstem Klamath River downstream

[185] This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

from Orleans, and especially downstream from the Trinity River (Appendix E.3.1.2), increases in suspended sediment in the mainstem Klamath River during critical migratory periods are currently low enough in concentration and short enough in duration that effects are limited to physiological stress and possibly inhibited growth, even during extreme conditions for fish. Current suspended sediment conditions and timing would remain unchanged under the No Project Alternative.

One of the main spawning streams for spring-run Chinook salmon, the Salmon River, has dramatically increased course sediment production over historical conditions as a result of legacy mining, road construction, timber harvest, and wildfire disturbance which leads to habitat degradation (Elder et al. 2002). Habitat degradation, much of which is a direct result of increased sedimentation, is believed to be the primary cause of the decline of the spring-run salmon population in the Klamath River system. Under the No Project Alternative, spawning and rearing habitat would remain in a degraded condition in both quantity and quality, and salmon production may be low in some years.

Under this alternative, dams would continue to block access to historical habitat, and spring-run Chinook salmon are likely to remain at significantly suppressed levels over the years of analysis (50 years). Under the No Project Alternative, there would be no change from existing conditions for spring-run Chinook salmon in the reasonably foreseeable short-term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-9 Effects on coho salmon populations due to continued operations of the Lower Klamath Project.

Under the No Project Alternative, Iron Gate Dam would continue to block access by coho salmon to historical habitat which used to extend upstream at least as far as Spencer Creek (Hamilton et al. 2005), including an estimated 76 miles of potential habitat within the Lower Klamath Project, based on approximately 54 miles of potential anadromous fish (steelhead) habitat in the Project Reach (NMFS 2006a, DOI 2007),[186] reduced in consideration of the more limited distribution of coho salmon relative to steelhead (DOI 2007), and including over 22 miles inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009), and habitat within the bypass reaches. The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009). The consequences of this ongoing loss of habitat to the population would include reduced resilience to recover from catastrophic disturbances of natural or anthropogenic origin, such as wildfire or chemical spills (Hamilton et al. 2011). Under the No Project Alternative access to cold water habitat would continue to be severely limited. Because areas upstream of the Iron Gate Dam include cold-water refugia for adult salmon and outmigrating smolts, opportunities for the population to adapt to changing temperatures would continue to be reduced. The above factors, which would continue under the No Project Alternative, reduce the natural genetic and life-history diversity found in Klamath Basin subpopulations of coho salmon that provide adaptive capacity and a sufficient number of subpopulations so that the population can withstand catastrophic events (NMFS 2014).

[186] This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

Under the No Project Alternative, upstream-migrating adult coho salmon would continue to be exposed to high water temperatures and poor water quality in part caused by Lower Klamath Project facilities (Section 3.2.2.2 *Water Temperature*) in the mainstem Klamath River, which can cause physiological stress, delay migration, reduce coldwater refugia, and increase mortality from disease. Under existing conditions maximum temperatures in the Klamath River downstream from Iron Gate Dam to the Klamath River Estuary regularly exceed the range of chronic effects temperature thresholds (55.4–68°F) for full salmonid support in California (North Coast Regional Board 2010, Sinnott 2010a, 2011a, 2012a; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Hanington 2013; Hanington and Ellien 2013) (see Appendix C for more detail). High water temperatures may promote higher incidence of disease or parasitism, which may increase direct and indirect mortality (Stutzer et al. 2006, NMFS 2010a). During a 2008 PIT-tag study of juvenile coho salmon in the Shasta River, Chesney et al. (2009) found juvenile coho salmon only in areas where temperatures were moderated by cold springs; the remainder of potential rearing habitat was too warm (>68°F). These detrimental temperature exceedances would continue under the No Project Alternative.

Effects of suspended sediment on coho salmon under the No Project Alternative and existing conditions are described in Appendix E.3.1.3. Under the No Project Alternative, SSCs in the mainstem would be sufficiently high and of long enough duration that coho salmon would continue to experience major physiological stress and reduced growth in most years.

Under the No Project Alternative, additional factors related to the Lower Klamath Project would continue to exacerbate the risk of disease downstream from Iron Gate Dam, including increased water temperatures and dampened flow and thermal variability, reduced dissolved oxygen concentrations, loss of sediment transport through the reach due to capture of sediment by the dams, and reservoirs contributing plankton to the filter-feeding polychaete hosts of the myxozoan parasites (as discussed above in Section 4.2.3.1 *Key Ecological Attributes [Fish Disease and Parasites]*). Under the No Project Alternative, downstream-migrating juvenile coho salmon may continue to have high disease infection rates (Bartholomew and Foott 2010) during summer months in some years. Heavy parasite loads may increase disease-related mortality in outmigrant smolts, particularly when water temperatures are high, or may reduce ocean survival by affecting growth or fitness (Holtby et al. 1990).

However, additional winter-spring surface flushing flows and deep flushing flow requirements outlined in *Measures to Reduce Ceratanova Shasta Infection of Klamath River Salmonids: A Guidance Document* and U.S. District Court Filing 111 (U.S. District Court 2017a–c; described in Section 4.2.3) is predicted to help reduce juvenile salmon disease below Iron Gate Dam. As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing flows were required in 2017 and 2018, with the intent of reducing disease in the Lower Klamath River by mobilizing bedload sediments. In addition, court ordered emergency dilution flows were required in 2018. As described in Section 3.1.6, the 2017 court-ordered flows include a requirement to ensure that certain high flows are reached each winter, and also include an emergency dilution requirement if juvenile fish disease reaches high levels in the infection nidus. The emergency dilution flows were used in 2018. While the flushing flows have not been occurring over a long enough time to allow collection of enough data on the efficacy of the flushing flows, the necessity to use the emergency dilution flows in 2018 suggest that the addition of the flushing flows is insufficient on its own to resolve the issue of fish disease downstream of Iron Gate Dam. Therefore, the No Project Alternative would result in continued substantial deleterious effects on coho salmon because of fish disease and parasites.

Under the No Project Alternative hatchery operations would continue. High numbers of hatchery fish may continue to impact the genetics and conditions for wild coho salmon (Noakes et al. 2000) in the Klamath Basin, as described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Fish Hatcheries]*. Data from Ackerman et al. (2006) indicate that substantial straying of Iron Gate Hatchery fish may be occurring into important tributaries of the Middle Klamath River. Straying has the potential to reduce the reproductive success of natural salmonid populations (Mclean et al. 2003, Chilcote 2003, Araki et al*.* 2007) and negatively affect the diversity of the populations via outbreeding depression[187] (Reisenbichler and Rubin 1999).

Coho salmon populations in the Klamath Basin are in decline; less than 70 percent of streams historically used by coho salmon in the Basin still contain small populations (NRC 2004). The No Project Alternative would likely support the continuation of blocked habitat access, water temperature impacts, and disease risk in the Klamath River that have helped to cause this decline (NMFS 2014). More detail on current conditions for coho salmon can be found in the NMFS (2010a) *BO on operation of the Klamath Project between 2010 and 2018*. Under the No Project Alternative, there would be no change from existing adverse conditions for coho salmon from all populations within the Klamath River watershed in the reasonably foreseeable short-term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short term (0−5 years)

Potential Impact 4.2.3-10 Effects on the steelhead population due to continued operations of the Lower Klamath Project.

Summer steelhead use the mainstem Klamath River primarily as a migration corridor because most spawning and rearing occurs in Klamath River tributaries. Under the No Project Alternative, summer steelhead spawning and rearing habitat availability and distribution would continue to be restricted during summer and fall to reaches downstream from Seiad Valley by high water temperatures farther upstream (NRC 2004). Conditions in the mainstem are generally suitable for adult upstream migration during the peak of migration (March through June); however, high water temperatures in the summer may restrict upstream migration of adults arriving towards the end of the typical migration season (FERC 2007). Prior to dams and major flow regulation, temperatures would have been cooler in the summer and fall months for adult migrating steelhead, potentially supporting a broader migratory period (Bartholow et al. 2005, FERC 2007). Altered flow patterns downstream from Iron Gate Dam associated with Lower Klamath Project facilities may thus be affecting the population by selecting for earlier-arriving fish, potentially reducing life-history diversity in the population. The effects to population dynamics experienced in existing conditions would continue under the No Project Alternative. In addition, under the No Project Alternative the altered flow and water temperature patterns would continue to cause an ongoing loss of habitat that might otherwise be contributing to smolt production, survival, and escapement.

[187] Outbreeding depression is the displacement of locally adapted genes in a wild population.

Fall and winter steelhead are more widely distributed than any other anadromous salmonid downstream from Iron Gate Dam. Under the No Project Alternative, steelhead would continue to be restricted from accessing 360 miles of historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood Rivers (Huntington 2006), including cold-water refugia that could buffer the population from the warming effects of climate change (Hamilton et al. 2005). In addition, there are around 80 miles of potential habitat for steelhead within the Klamath Hydroelectric Project that are currently inaccessible, comprising approximately 58 miles of anadromous habitat with the Project reach (NMFS 2006a, DOI 2007), that includes over 22 miles inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009) and habitat within the bypass reaches. The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009). As with summer steelhead, fall and winter steelhead use the mainstem primarily as a migration corridor to access tributaries for spawning. Under the No Project Alternative, high summer water temperatures in the summer months would continue to cause density-independent mortality on juveniles that have left spawning tributaries to rear in the mainstem.

Effects of suspended sediment on steelhead under the No Project Alternative and existing conditions are described in Appendix E.3.1.4. Overall, steelhead use the mainstem Klamath River as a migratory corridor during adult migration, and downstream smolt migration, and for juvenile rearing. SSCs under the No Project Alternative would continue to be relatively high in the mainstem Klamath River downstream from Orleans, and especially downstream from the Trinity River (State Water Control Board 2006, North Coast Regional Board 2010) (see Appendix E.3.1.4, and Section 3.2.2.3). However, SSCs in the mainstem Klamath River during critical migratory periods, even during extreme conditions for fish, would continue to be low enough with short exposure times that effects on steelhead would likely be limited to physiological stress and possibly reduced growth rates (Appendix E.3.1.4). Conditions for juvenile steelhead rearing in the mainstem would likely be worse and include mortality of up to 20 percent during extreme conditions for fish, but in general steelhead appear resilient to the suspended sediment regimes that occur under existing conditions and would persist under the No Project Alternative.

Under the No Project Alternative, additional factors related to the Lower Klamath Project would continue to exacerbate the risk of disease downstream from Iron Gate Dam, including increased water temperatures and dampened flow and thermal variability, reduced dissolved oxygen concentrations, loss of sediment transport through the reach due to capture of sediment by the dams, and reservoirs contributing plankton to the filter-feeding polychaete hosts of the myxozoan parasites (as discussed above in Section 4.2.3.1 *Key Ecological Attributes [Fish Disease and Parasites]*). Under the No Project Alternative, downstream-migrating juvenile steelhead may continue to have high disease infection rates (Bartholomew and Foott 2010) during summer months in some years (although steelhead are generally resistant to *C. shasta)*. Heavy parasite loads may increase disease-related mortality in outmigrant smolts, particularly when water temperatures are high, or may reduce ocean survival by affecting growth or fitness (FERC 2007).

However, additional winter-spring surface flushing flows and deep flushing flow requirements outlined in *Measures to Reduce Ceratanova Shasta Infection of Klamath*

River Salmonids: A Guidance Document and U.S. District Court Filing 111 (U.S. District Court 2017a–c; described in Section 4.2.3) is predicted to help reduce juvenile salmon disease below Iron Gate Dam. As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing flows were required in 2017 and 2018, with the intent of reducing disease in the Lower Klamath River by mobilizing bedload sediments. In addition, court ordered emergency dilution flows were required in 2018. As described in Section 3.1.6, the 2017 court-ordered flows include a requirement to ensure that certain high flows are reached each winter, and also include an emergency dilution requirement if juvenile fish disease reaches high levels in the infection nidus. The emergency dilution flows were used in 2018. While the flushing flows have not been occurring over a long enough time to allow collection of enough data on the efficacy of the flushing flows, the necessity to use the emergency dilution flows in 2018 suggest that the addition of the flushing flows is insufficient on its own to resolve the issue of fish disease downstream of Iron Gate Dam. Therefore, the No Project Alternative would result in continued substantial deleterious effects on steelhead because of fish disease and parasites.

Habitat conditions for juvenile steelhead rearing in the mainstem below Iron Gate Dam are generally suitable, except for reaches upstream of Seiad Valley where summer water temperatures are considered stressful. Under existing conditions maximum temperatures in the Klamath River downstream from Iron Gate Dam to the Klamath River Estuary regularly exceed the range of chronic effects temperature thresholds (55.4–68°F) for full salmonid support in California (North Coast Regional Board 2010, Sinnott 2010a, 2011a, 2012a; Watercourse Engineering, Inc. 2011a, 2011b, 2012, 2013, 2014, 2015, 2016; Hanington 2013; Hanington and Ellien 2013) (see Appendix C for more detail). These detrimental temperature exceedances would continue under the No Project Alternative. Juvenile outmigration peaks in the spring and extends through the summer and fall. Growth during their rearing and outmigration may be reduced by high temperatures (unless food availability is high) due to increased metabolism, which can reduce ocean survival (Scheuerell et al. 2009). High summer water temperatures causing physiological stress to fish can also make them more vulnerable to mortality from disease or other compounding factors. These conditions, and the resulting effects on juvenile steelhead in the mainstem Klamath River, would remain unchanged under the No Project Alternative. Under the No Project Alternative, there would be no change from existing conditions for steelhead in the reasonably foreseeable short-term (0−5 years).

<u>Significance</u>

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-11 Effects on the Pacific lamprey population due to continued operations of the Lower Klamath Project.

Pacific lamprey populations appear to have been in decline since the late 1980s in the Klamath Basin (Larson and Belchik 1998 as cited in Hamilton et al. 2011), and are considered “vulnerable” throughout their range by the American Fisheries Society (Jelks et al. 2008, as cited in Hamilton et al. 2011). Major factors believed to be affecting their populations include barriers to upstream migration at dams; dewatering of larval habitat through flow regulation; reducing larval habitat by increasing water velocity and/or reducing sediment deposition areas; and susceptibility to contaminants in the larval stage (Close et al. 2002, as cited in Hamilton et al. 2011).

Under the No Project Alternative, Iron Gate Dam would continue to form a barrier to Pacific lamprey migration, which represents an ongoing loss of available habitat and productive capacity. Although the exact upstream extent of suitable habitat for Pacific lamprey prior to the completion of the Lower Klamath Project dams and associated facilities is unknown, it is believed that Pacific lamprey would have migrated at least as far as Spencer Creek (Hamilton et al. 2005), including an estimated 80 miles of potential habitat within the Lower Klamath Project, based on approximately 58 miles of potential anadromous fish (steelhead) habitat in the Project Reach (NMFS 2006a, DOI 2007),[188] and including over 22 miles inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009), and habitat within the bypass reaches. The loss of this portion of spawning and larval rearing habitat reduces the viability of the Klamath Basin population by contracting its distribution within the watershed and reducing abundance.

Under the No Project Alternative, the dams would continue to reduce sediment supply to the mainstem Klamath River downstream from Iron Gate Dam, which may limit availability of gravel-cobble substrates for nest building and fine sediment for burrowing. Armoring of substrate would continue to occur downstream of Iron Gate Dam and would continue to also reduce spawning habitat quality. Despite these effects, in part caused by Lower Klamath Project facilities, the overall effect to Pacific lamprey populations in the Klamath Basin is likely to be small because (1) the effects of the dam on fine sediment and gravel/cobble substrates diminish with distance downstream because of input from tributaries and become less significant downstream from Cottonwood Creek (RM 185.1) (which is approximately 8 RM downstream of Iron Gate Dam), and (2) a large proportion of the population may spawn and rear in large tributaries to the mainstem, such as the Trinity, Salmon, Shasta, and Scott rivers.

Effects of suspended sediment on Pacific lamprey under the No Project Alternative and existing conditions are described in Appendix E.3.1.5. Overall, under all conditions, Pacific lamprey under the No Project Alternative are anticipated to suffer from stressful levels of suspended sediment while rearing and migrating through the mainstem Klamath River during winter, with exposure durations generally much longer under extreme conditions for lamprey. Because there are multiple year-classes of lamprey with a broad spatial distribution in the Klamath River Basin at any given time, and since adults may migrate upstream throughout the year (and thus some adults avoid peaks in SSC), Pacific lamprey populations may be well-adapted to persisting through years when SSCs are high in the mainstem.

The effects of Lower Klamath Project dams and reservoirs would continue to affect water quality downstream from Iron Gate Dam under the No Project Alternative, which may reduce habitat quality for spawning and rearing Pacific lamprey, as well as reproductive success. Under existing conditions maximum temperatures in the Klamath River downstream from Iron Gate Dam to the Klamath River Estuary regularly exceed the range of chronic effects temperature thresholds (64.4–71.6°F) for Pacific lamprey spawning and rearing (Meeuwig et al. 2005) (see Appendix C for more detail). These detrimental temperature exceedances would continue under the No Project Alternative.

Flow management under the No Project Alternative would continue to modify temperature and instream flow patterns relative to pre-project conditions which would

[188] This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

continue to alter the migration of patterns of adult, ammocoete, and macropthalmia Pacific lamprey (Stone et al. 2002, Luzier and Miller 2009), and may reduce survival (Stone et al. 2002). Under the No Project Alternative, regulated flow patterns and their potential effect on Pacific lamprey would remain the same as under existing conditions.

Under the No Project Alternative, Pacific lamprey populations in the Klamath Basin may remain at current levels or population numbers may continue to decline over the long term (Close et al. 2010). Because so little is known of Pacific lamprey life history and habitat requirements compared to those of anadromous salmonids, it is more difficult to predict the potential effects of alternatives on their abundance and distribution. Under the No Project Alternative, there would be no change from existing conditions for Pacific lamprey in the reasonably foreseeable short term (0−5 years).

Significance
No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-12 Effects on the green sturgeon population due to continued operations of the Lower Klamath Project.
Green sturgeon spend a majority of their lives in estuaries, bays, and nearshore waters, with adults only returning to fresh water to spawn after more than 15 years and spawning every 4 years on average (Klimley et al. 2007).

Northern green sturgeon spawn in the Rogue, Klamath, and Umpqua rivers. The Klamath Basin supports the largest spawning population of Northern Green Sturgeon (Moyle 2002), so it plays a critically important role in the viability and persistence of the entire DPS. In the Klamath River mainstem, green sturgeon spawn and rear in the lower 67 miles, downstream from Ishi Pishi Falls which forms a natural migratory barrier to green sturgeon. Concentration of spawning in only a very few areas renders these spawning populations vulnerable to local catastrophic impacts. A loss of any of the few spawning areas would have much greater effects than the loss of a spawning population of salmon that spawn in many other streams throughout their range.

Under existing conditions maximum temperatures in the Klamath River downstream from Iron Gate Dam to the Klamath River Estuary (including downstream of Ishi Pishi Falls) regularly exceed the range of temperature thresholds for green sturgeon spawning and egg incubation (62.6–78.8°F) (Van Eenennaam et al. 2005, Cech et al. 2000) (see Appendix C for more detail), especially during low water years. These detrimental temperature exceedances reducing the reproductive success of green sturgeon would continue under the No Project Alternative.

Effects of suspended sediment on green sturgeon under the No Project Alternative and existing conditions are described in Appendix E.3.1.6. Under existing conditions, green sturgeon in the Klamath River mainstem are regularly exposed to SSCs documented to cause major physiological stress, reduced growth, and mortality in other fish species, especially during their egg and larval stages, and the year-round juvenile rearing period. Exposure of green sturgeon to these SSCs would continue under the No Project Alternative. However, based on the persistence of their population under these conditions, these metrics likely overestimate effects on green sturgeon. Under the No Project Alternative, there would be no change from existing conditions for green sturgeon in the reasonably foreseeable short-term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-13 Effects on Lost River and shortnose sucker populations due to continued operations of the Lower Klamath Project.

Under current conditions, Lost River and shortnose suckers in the Area of Analysis suffer mortality by entrainment in hydroelectric turbines at all Lower Klamath Project hydroelectric facilities (PacifiCorp 2013). Additionally, suckers would continue to be stranded due to peaking operations downstream of J.C. Boyle Dam (PacifiCorp 2013).

Under the No Project Alternative, there would be no change from existing conditions for Lost River and shortnose sucker populations in the reasonably foreseeable short term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-14 Effects on the redband trout population due to continued operations of the Lower Klamath Project.

Resident trout upstream of Iron Gate Dam are considered to be redband trout. Before construction of the Lower Klamath Project dams and associated facilities, redband trout in the area belonged to one population, with no migration barriers isolating populations from one another (NMFS 2006a). Under the No Project Alternative, genetic exchange and movement by redband trout between reaches would continue to be limited by the partially functional J.C. Boyle fish ladder (NMFS 2006a) and lack of fish ladders at the Copco No. 1 and 2 Dams, as would access to productive spawning habitat in Spencer Creek in the J.C. Boyle Bypass and Peaking Reaches (NMFS 2006a). The fragmentation of this population into several smaller, isolated subpopulations renders each more vulnerable to extinction due to stochastic events (wildfire, landslides, disease outbreaks, etc.) and limits genetic exchange among subpopulations.

Under the No Project Alternative, habitat connectivity for redband trout in the Klamath River would continue to be compromised by structural features of the Lower Klamath Project dams and associated facilities developments as well as by project operations. Fish downstream from J.C. Boyle Dam would continue to be hindered or obstructed from migrating to spawning grounds in Spencer Creek by the ineffective fish ladder at J.C. Boyle Dam, which poses a partial passage barrier (Hamilton et al. 2011). Spencer Creek is a highly productive spawning and rearing habitat for rainbow/redband trout (Hamilton et al. 2011). The stock of rainbow/redband trout in the bypass and peaking reaches below J.C. Boyle Dam is currently restricted from Spencer Creek and other suitable habitat upstream of the J.C. Boyle Dam (NMFS 2006a). Migration over the Copco No. 1 and 2 dams is in the downstream direction only, as there is no fishway. These conditions would remain unchanged under the No Project Alternative and the redband trout population would continue to suffer the effects of restricted habitat connectivity.

Under existing conditions, the lack of fully functioning fish screens at Iron Gate, Copco No. 1, and Copco No. 2 dams results in entrainment and loss of juvenile redband trout and reduces recruitment of redband trout to downstream reaches (DOI 2007). All Lower Klamath Project hydropower facilities use Francis turbines. A 1987 report prepared by the Electric Power Research Institute (EPRI 1987) concluded that fish mortality from entrainment at hydroelectric projects using Francis turbines averaged 24 percent. It is estimated that “several tens of thousands of resident fish” are annually entrained at “each of the Projects” facilities (NMFS 2006a), and it is likely that these entrainment and mortality rates would continue under the No Project Alternative.

The health and productivity of redband trout in the J.C. Boyle Peaking Reach and J.C. Boyle Bypass Reach would continue to be affected under the No Project Alternative. Obstruction of sediment transport at J.C. Boyle Dam has altered substrates and channel features in the peaking and bypass reaches (FERC 2007). High flows have mobilized and removed sediment from storage sites and transported it downstream, reducing habitat quality for redband trout as well as for the macroinvertebrates they feed on (NMFS 2006a). These effects would continue under the No Project Alternative. In the J.C. Boyle Peaking Reach, redband trout numbers would continue to be subject to large fluctuations in flows that would: (1) cause fluctuations in water temperature and pH, (2) strand fish, (3) displace fish downstream, (4) reduce fry habitat along channel margins, (5) reduce access to suitable gravels where they are affected by flow fluctuations, and (6) reduce macroinvertebrate food production by reducing the area of the channel suitable for their survival (City of Klamath Falls 1986, Addley et al. 2005, as cited in Hamilton et al. 2011). All of these conditions could result in substantial declines in redband trout abundance in this reach.

Under the No Project Alternative, diversion of water at continue to alter flows downstream, as occurs under existing conditions. Reduced flows in the 1.4-mile-long Copco No. 2 Bypass Reach would continue to prevent redband trout from using what would otherwise be habitat suitable for spawning and rearing. Productivity of redband trout in the bypass and peaking reaches downstream of J.C. Boyle Dam would continue to be suppressed by Lower Klamath Project effects that limit spawning and rearing habitat in these reaches (Hamilton et al. 2011). Under existing conditions, spawning of redband trout downstream of J.C. Boyle Dam appears limited to an area just downstream from the emergency canal spillway (Hamilton et al. 2011). Patches of gravel that might otherwise be suitable for spawning are rendered inaccessible to redband trout by reductions in instream flows (NMFS 2006a, Hamilton et al. 2011). These conditions would continue under the No Project Alternative.

Reduced redband trout abundance and distribution upstream of Iron Gate Dam attributable to Lower Klamath Project features and operations would continue under the No Project Alternative. Habitat connectivity and suitability are substantially reduced in the Hydroelectric Reach due in part to Lower Klamath Project facilities isolating population units by limiting migration and reducing habitat suitability. Apparent phenotypic changes in the redband trout in these reaches would likely be maintained or continue under the No Project Alternative, such as declines in size (Jacobs et al. 2007, as cited in Hamilton et al. 2011) and condition factor (ODFW 2003, as cited in Hamilton et al. 2011). The effect of the No Project Alternative would be no change from existing conditions for redband trout in the reasonably foreseeable short-term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-15 Effects on the eulachon population due to continued operations of the Lower Klamath Project.

Under the No Project Alternative, habitat conditions in the estuary for eulachon would remain the same as they are under existing conditions. Although very little is known about the factors leading to decline of the eulachon, there is no evidence that the No Project Alternative would contribute to a continued decline of the population. The No Project Alternative would therefore have no significant impact on eulachon in the reasonably foreseeable short-term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-16 Effects on the longfin smelt population due to continued operations of the Lower Klamath Project.

Longfin smelt populations in the Klamath River are discussed in Section *3.3.2.1 Aquatic Species [Longfin smelt]* of this EIR. The No Project Alternative would have no effect on longfin smelt and there would be no change from existing conditions in the reasonably foreseeable short-term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-17 Effects on species interactions between introduced resident fish species and native aquatic species due to continued operations of the Lower Klamath Project.

Introduced fish species threaten the diversity and abundance of native fish species through competition for resources, predation, interbreeding with native populations, and causing potential physical changes to the invaded habitat (Moyle 2002). Introduced resident species occur within reservoirs upstream of Iron Gate Dam, and infrequently downstream from Iron Gate Dam. Under the No Project Alternative, conditions favorable for introduced species would continue to occur within the Lower Klamath Project reservoirs (Buchanan et al. 2011). The No Project Alternative would not change habitat conditions or alter populations of introduced resident fish species. The impacts of these introduced species on native aquatic species would remain unchanged in the short term relative to existing conditions.

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-19 Effects on freshwater mollusks populations due to continued operations of the Lower Klamath Project.

Freshwater mollusk populations in the Klamath River are discussed in Section *3.3.2.1 Aquatic Species [Freshwater mollusks]* of this EIR. Four species of native freshwater mussels have been observed within the Klamath Basin, including Oregon floater (*A. oregonensis*), California floater (*A. californiensis*), western ridged mussel (*G. angulata*), and western pearlshell mussel (*M. falcata*). Seven to eight species of fingernail clams and peaclams (Family: Sphaeriidae) also occur in the Hydroelectric Reach and from Iron Gate Dam to Shasta River. Based on freshwater mollusk life history and habitat preferences, freshwater mollusks are strongly affected by alterations to instream flows, suspended sediment, and bedload sediment. Under the No Project Alternative there would be no change in instream flows, suspended sediment, or bedload sediment, and thus under the No Project Alternative there would be no change from existing conditions for freshwater mussels in the reasonably foreseeable short-term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-20 Effects on fish species from alterations to benthic macroinvertebrates due to continued operations of the Lower Klamath Project.

Under existing conditions, J.C. Boyle peaking operations kill, through stranding, large numbers of young fish and aquatic invertebrates that are the primary prey food for resident trout (NMFS 2006a). Current peaking operations reduce the production of sessile organisms, like macroinvertebrates, by 10 to 25 percent (Administrative Law Judge (2006). Fluctuations in the peaking reach are considered to be a contributing factor to the lower macroinvertebrate drift rates (NMFS 2006a). Under the No Project Alternative, there would be no change from existing adverse conditions on effects of alterations to benthic macroinvertebrates on fish species in the reasonably foreseeable short-term (0−5 years).

Significance

No significant impact in the reasonably foreseeable short-term (0−5 years)

Potential Impact 4.2.3-21 Alterations to aquatic habitat from implementation of California Klamath Restoration Fund/Coho Enhancement (IM2)

Under the No Project Alternative, in the short term, PacifiCorp would continue to provide funding for the California Klamath Restoration Fund/Coho Enhancement Fund as an Interim Measure (IM2) (Table 4.2-1). This would continue to fund the implementation of specific projects or actions that would create, maintain, and improve access by coho salmon to important tributary habitats downstream from Iron Gate Dam that are within the potential range of the Upper Klamath coho salmon population. The PacifiCorp IM2 projects involve removal of existing fish passage barriers, improving/maintaining habitat cover and complexity at coldwater refugia sites, providing livestock exclusion, increasing the duration and/or extent of coldwater refugia sites, enhancing habitat in rearing tributaries, restoring connectivity of juvenile rearing habitat in tributaries of the Upper Klamath, Scott, and Shasta Rivers, funding a program to provide flow augmentation in key reaches used for coho spawning and juvenile rearing in the Upper Klamath, Scott, and Shasta Rivers, enhancing habitat in rearing tributaries of the Upper Klamath, Scott, and Shasta Rivers, and protecting summer rearing habitat in tributaries of the Upper Klamath, Scott, and Shasta Rivers (PacifiCorp 2012).

Based on anticipated improvements in habitat availability and habitat quality, continued implementation of the Coho Enhancement Fund under the No Project Alternative would continue to provide benefits to fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, freshwater mussels, and benthic macroinvertebrates in the short term. These actions are also beneficial for coho salmon (particularly from the Upper Klamath River Population Unit). Implementation of the Coho Enhancement Fund under the No Project Alternative would have no significant impact (no change from existing conditions) on redband trout, shortnose and Lost River suckers, green sturgeon, eulachon, and Southern Resident Killer Whales, since these species are not found in or near the river reaches associated with IM2 projects or actions.

Significance

Beneficial for coho salmon, fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, freshwater mussels, and benthic macroinvertebrates in the reasonably foreseeable short-term (0−5 years)

No significant impact for redband trout, shortnose and Lost River suckers, green sturgeon, eulachon, and Southern Resident Killer Whales in the reasonably foreseeable short-term (0−5 years)

4.2.4 Phytoplankton and Periphyton

4.2.4.1 Phytoplankton

As discussed in more detail in Section 3.4 *Phytoplankton and Periphyton*, phytoplankton are aquatic microscopic organisms, including algae, bacteria, protists, and other single-celled plants, that obtain energy through photosynthesis and float in the water column of still or slowly flowing waters such as lakes or reservoirs. Excess growth of these organisms can cause nuisance water quality conditions, such as extreme diel (daily) fluctuations in dissolved oxygen and pH (see Section 3.4.2.1 *Phytoplankton*). Under the No Project Alternative, phytoplankton existing conditions, including adverse, large, seasonal blue-green algae blooms, would continue to occur in the Klamath River. In the Hydroelectric Reach, seasonal phytoplankton (including blue-green algae) blooms originating from Upper Klamath Lake in Oregon would still be able to enter J.C. Boyle Reservoir under this alternative, but the short residence time of this reservoir would not support substantial additional growth of phytoplankton similar to existing conditions (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). Further downstream in the Hydroelectric Reach, adverse, large, seasonal phytoplankton blooms, including blue-green algae, would continue to occur in Copco No. 1 and Iron Gate reservoirs under the No Project Alternative similar to existing conditions (see also Section 3.4.2.3 *Hydroelectric Reach*) since the reservoirs would remain in place. Overall, the No Project Alternative would result in no change from existing adverse conditions, so there would be no significant impact to phytoplankton in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative in the Hydroelectric Reach.

The Lower Klamath Project reservoirs would remain in place under the No Project Alternative, so Copco No. 1 and Iron Gate reservoirs would continue to provide ideal habitat conditions for the proliferation of large seasonal blooms of *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, and *Microcystis aeruginosa*, which subsequently become the source of these species to the Middle and Lower Klamath River, and eventually the Klamath River Estuary (see also Section 3.4.2.3 *Hydroelectric Reach* and Section 3.4.2.4 *Middle and Lower Klamath River*). Genetic analysis of *Microcystis aeruginosa* variations at Klamath River locations upstream of Copco No. 1 Reservoir, within Copco No. 1 and Iron Gate reservoirs, and at multiple Klamath River locations from downstream of Iron Gate Dam to Turwar indicate that Iron Gate Reservoir is the principal source of *Microcystis aeruginosa* cells to the Middle and Lower Klamath River (Otten et al. 2015) (see also Section 3.4.2.4 *Middle and Lower Klamath River*). There would be no change to the habitat conditions that promote growth of *Microcystis aeruginosa* in Iron Gate Reservoir under existing conditions (see also Section 3.4.2.3 *Hydroelectric Reach*), so the export of *Microcystis aeruginosa* cells from this reservoir would also continue to occur under the No Project Alternative similar to existing conditions.

The 2017 court-ordered flushing and emergency dilution flows would result in no change from existing conditions for phytoplankton in the Klamath River. In the Hydroelectric Reach, habitat conditions in Copco No. 1 or Iron Gate reservoirs that result in adverse, large, seasonal phytoplankton blooms, including blue-green algae, would continue to be the same as existing conditions under these releases. In the Middle Klamath River and further downstream in the Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment, court-ordered flushing and emergency dilution flows would result in no change from existing conditions for phytoplankton since the releases would primarily occur during winter and spring when phytoplankton abundance in Iron Gate Reservoir would be low (see also Section 3.4.2.3 *Hydroelectric Reach*). Court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would end by June 15, while monitoring data from the past five years (i.e., 2013 to 2018) indicates the abundance of blue-green algae in Iron Gate Reservoir increases after late June to early July (E&S Environmental Chemistry, Inc. 2013, 2014, 2015, 2016, 2018a, 2018b). Assuming blue-green algae cell counts and algal toxin concentrations from the past five years are representative of likely conditions in the reasonably foreseeable short-term (0−5 years), releases would end before elevated levels of blue-green algae occur in Iron Gate Reservoir. There would be no changes from existing conditions for blue-green algae abundance in the reasonably foreseeable short-term (0−5 years), thus there would be no significant impact to phytoplankton in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative in the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment.

Under the No Project Alternative, reservoir sediment deposits would not be mobilized in the Hydroelectric Reach, Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment, so there would be no short-term increases in sediment-associated nutrients that could potentially stimulate nuisance and/or noxious phytoplankton growth in those reaches (Potential Impact 3.4-1). Thus, there would be no significant impact.

As described under the Proposed Project (Potential Impact 3.2-1), climate change would be anticipated to only significantly influence existing conditions in the long term (5+ years), so climate change is not discussed further for phytoplankton under the No Project Alternative. Similarly, other long-term processes that would potentially alter phytoplankton abundance such as the gradual increase in nutrients and organic matter in reservoir sediments (i.e., reservoir aging [USGS 2018]) and implementation of nutrient reduction or other measures in Oregon and California to meet Klamath River TMDLs are not analyzed as part of the reasonably foreseeable short-term (0−5 years). As noted in Section 4.2.1.1 *[No Project Alternative] Alternative Description– Foreseeable Short-term Operations*, the long-term outcomes are considered in the Proposed Project and other alternatives, thus the long-term potential impacts to phytoplankton are described in: Section 3.4.5.1 *Phytoplankton;* Section 4.3.4.1 *Phytoplankton*; Section 4.4.4.1 *Phytoplankton*; Section 4.5.4.1 *Phytoplankton*; Section 4.6.4.1 *Phytoplankton*; and Section 4.7.4.1 *Phytoplankton.*

4.2.4.2 Periphyton

As discussed in more detail in Section 3.4, periphyton are aquatic organisms including aquatic plants, algae, and bacteria that live attached to underwater surfaces such as rocks on a riverbed. Some degree of periphyton growth is an important part of stream ecosystem function. Excess growth of these organisms can cause nuisance water quality conditions, such as extreme diel (daily) fluctuations in dissolved oxygen and pH (see Section 3.4.2.2 *Periphyton* for detail. Under the No Project Alternative, periphyton existing conditions would continue to occur in the Klamath River, since there would be no substantial change to the periphyton habitat conditions along the margins and riverbed of the Klamath River. In the Hydroelectric Reach from J.C. Boyle Reservoir through the J.C. Boyle Bypass and Peaking Reach to Copco No. 1 Reservoir, the flows and hydropower peaking operations would continue, thus there would be no change from existing conditions that do not currently support excessive periphyton mats in the J.C. Boyle Peaking Reach due to the generally high gradient and velocity (see Section 3.4.2.2 *Periphyton*). Further downstream from Copco No. 1 Reservoir to Iron Gate Dam, the reservoirs would remain in place, so there would be no change in the limited habitat conditions for periphyton growth that occur under existing conditions. Thus, there would be no significant impact to periphyton in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative in the Hydroelectric Reach.

Under the No Project Alternative, reservoir sediment deposits would not be mobilized in the reasonably foreseeable short-term (0−5 years) to the Hydroelectric Reach, Middle and Lower Klamath River, or the Klamath River Estuary, and there would be no increases in sediment-associated nutrients in these river reaches that could stimulate nuisance periphyton growth. Additionally, there would be no conversion of the reservoir areas to free-flowing river or elimination of hydropower peaking operations under the No Project Alternative, so there would be no change in periphyton abundance from existing conditions due to increased low-gradient channel margin habitat conditions. While nutrients do not appear to be limiting periphyton growth in the Klamath River from Iron Gate Dam to approximately Seiad Valley (RM 132.7) (and potentially farther downstream) (see also Potential Impact 3.4-5), nutrients would be similar to existing conditions under the No Project Alternative (see Section 4.2.2 *Water Quality, Nutrients*), so periphyton growth or abundance would be the same relative to existing conditions due to nutrients conditions under this alternative. There would be no change in nutrient transport from existing conditions in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative, since the reservoirs would continue to intercept upstream nutrients and phytoplankton cells containing nutrients generated in the reservoirs and seasonal export of nutrients from reservoir sediments would continue to occur.

As described under the Proposed Project (Potential Impact 3.2-1), climate change would be anticipated to only significantly influence existing conditions in the long term (5+ years), so climate change is not discussed further for periphyton under the No Project Alternative. Similarly, other long-term processes that would potentially alter periphyton abundance such as implementation of nutrient reduction or other measures in Oregon and California to meet Klamath River TMDLs are not analyzed as part of the reasonably foreseeable short-term (0−5 years). As noted in Section 4.2.1.1 *[No Project Alternative] Alternative Description– Foreseeable Short-term Operations*, the long-term outcomes, including nutrient build-up in the reservoirs and the basin response to the nutrient reduction measures, are considered in the Proposed Project and other alternatives, thus the long-term potential impacts to phytoplankton are described in: Section 3.4.5.2 *Periphyton;* Section 4.3.4.2 *Periphyton*; Section 4.4.4.2 *Periphyton*; Section 4.5.4.2 *Periphyton*; Section 4.6.4.2 *Periphyton*; and Section 4.7.4.2 *Periphyton.*

Other potential impacts related to periphyton in the foreseeable short-term (0−5 years) under the No Project Alternative are discussed under a new impact heading, below.

Potential Impact 4.2.4-1 Variations in nuisance periphyton species abundance downstream of Iron Gate Dam due to implementation of 2017 court-ordered flushing and emergency dilution flows.
In the Middle and Lower Klamath River, seasonal shifts in water temperature downstream of the reservoirs and flow modification due to the continuing presence of the Lower Klamath Project dams would continue to support periphyton growth, including nuisance periphyton species, in the Middle and Lower Klamath River similar to existing conditions, but court-ordered flushing flows and emergency dilution releases would reduce periphyton abundance in the Middle Klamath River downstream of Iron Gate Dam relative to existing conditions. Higher fall water temperatures occurring under existing conditions due Iron Gate Dam (see Section 3.2.2.2 *Water Temperature*) would continue in the Middle Klamath River to the confluence with the Salmon River under the No Project Alternative (see Section 4.2.2 *Water Quality*), thus periphyton growth would continue to be promoted in this reach of the Middle Klamath River similar to existing conditions. Water temperature downstream of the confluence with the Salmon River, including the Klamath River Estuary and the Pacific Ocean nearshore environment, and its influence on periphyton growth and abundance would be the same as under existing conditions under the No Project Alternative, since there is no influence of the dams on water temperature downstream of the confluence with the Salmon River.

While the presence of the Lower Klamath Project dams would continue to support periphyton growth in the Middle and Lower Klamath River as described for existing conditions (Section 3.4.2.4 *[Periphyton] Middle and Lower Klamath River*), 2017 court-ordered flushing releases downstream of Iron Gate Dam under the No Project Alternative would increase mobilization of riverbed sediment downstream of Iron Gate Dam between November 1 to May 31 (see Potential Impact 4.2.2-3). Emergency dilution releases (3,000 to 4,000 cfs) are below the flow recognized to mobilize sediment along the riverbed downstream of Iron Gate Dam. Increases in sediment transport due to flushing flows under this alternative would dislodge periphyton from the riverbed and decrease periphyton abundance downstream of Iron Gate Dam in the Middle Klamath River immediately after releases. Currently, there are not sufficient data to determine how far downstream of Iron Gate Dam the effect of bed turnover and scouring on periphyton would extend under the 2017 court-ordered flushing flows. This analysis assumes that periphyton scouring potential would extend from Iron Gate Dam until approximately the Shasta River (RM 179.5), as the first major tributary that would contribute additional flows to the mainstem river. While periphyton naturally re-establish and re-grow following high winter flows under existing conditions and periphyton are anticipated to re-establish and re-grow similarly after flushing flows, the frequency of flushing flows (i.e., annually for surface flushing and every other year for deep flushing) would result in a reduction in periphyton abundance downstream of Iron Gate Dam in the Middle Klamath River to approximately the confluence with the Salmon River. Overall, flushing releases under this alternative would reduce dense growth of periphyton relative to existing conditions, and would be beneficial in the reasonably foreseeable short-term (0−5 years) under the No Project Alternative.

Significance

Beneficial for the Middle Klamath River from Iron Gate Dam to the Shasta River (RM 179.5)

No significant impact for the Middle Klamath River from the confluence with the Shasta River (RM 179.5) and the Lower Klamath River

4.2.5 Terrestrial Resources

Except for the potential impacts to foothill yellow-legged frogs and Western Pond Turtles due to 2017 flow requirements (see Potential Impact 4.2.5-1, below) there would be no change to terrestrial resources in the short term under the No Project Alternative. Thus, except for Potential Impact 4.2.5-1, under the No Project Alternative short term conditions for terrestrial resources would be the same as the existing conditions described in Section 3.5.2 *Terrestrial Resources, Environmental Setting,* including the subsections: 3.5.2.1 *Vegetation Communities,* 3.5.2.2 *Invasive Plant Species,* 3.5.2.3 *Culturally Significant Plant Species*, 3.5.2.4 *Non-special-status Wildlife,* 3.5.2.4 *Special-status Species*, and 3.5.2.6 *Wildlife Corridors and Habitat Connectivity.*

4.2.5.1 Vegetation Communities

Under the No Project Alternative, in the short term (0−5 years), there would be no habitat loss or gain for wetland or riparian vegetation as compared with existing conditions, since ground-disturbing construction activities, reservoir drawdown, and dam removal would not occur. Thus, there would be no significant impacts to wetland or riparian vegetation in the short term (0−5 years) under the No Project Alternative.

4.2.5.2 Culturally Significant Species

Under the No Project Alternative, in the short term (0−5 years), there would be no habitat loss or gain for culturally significant plant species as compared with existing conditions since the Lower Klamath Project reservoirs and associated riparian habitat would remain unchanged and would continue to provide habitat for these species. Thus, there would be no significant impacts to culturally significant plant species in the short term (0−5 years) under the No Project Alternative.

4.2.5.3 Special-status Species

Under the No Project Alternative, in the short term (0−5 years), there would be no habitat loss or gain for special-status plant and wildlife species as compared with existing conditions since the Lower Klamath Project reservoirs would remain and would continue to provide habitat for western pond turtle, multiple bird species, including waterfowl and bald eagles, bats, and other special-status wildlife and plants that are supported by the Lower Klamath Project reservoirs and Iron Gate Hatchery. Populations of special-status plant and wildlife species and rare natural vegetation communities would continue to be influenced by various stressors in the Klamath Basin, including habitat degradation from the Lower Klamath Project and invasive species.

Klamath River hydrology in the short term (0−5 years) would be similar to existing conditions under the No Project Alternative with the addition of the 2017 court-ordered flushing and emergency dilution flows released from Iron Gate Dam to the Middle Klamath River; these flows are described in detail in Section 4.2.1.1 *[No Project Alternative] Alternative Description – Summary of Available Hydrology Information for the No Project Alternative*. Potential Impact 4.2.5-1 (below) assesses the potential for the additional court-ordered flow releases from Iron Gate Dam to affect breeding foothill yellow-legged frog in the short term (0−5 years).

Since Iron Gate Hatchery would continue to obtain water from Iron Gate Reservoir, no flow diversion would occur in Bogus Creek to supply water to Iron Gate Hatchery; therefore, there would be no significant impact to aquatic amphibians and reptiles in the short term (0−5 years) under the No Project Alternative.

Since no dewatering of the reservoirs or sediment would be released from behind the dams during the dam removal process, no elevated suspended sediment concentrations (SSCs) would occur nor would they have the potential to affect special-status amphibians and reptiles. Thus, there would be no SSC-associated impacts to special-status amphibians and reptiles in the short term (0−5 years) under the No Project Alternative.

Under the No Project Alternative, there would be no construction-related impacts on special-status plant and wildlife species, including nesting birds or bats, as no construction activities with the potential to remove suitable nesting/roosting habitat would occur in the short term. Thus, there would be no significant impacts to special-status plant and wildlife species in the short term (0−5 years) under the No Project Alternative.

Potential Impact 4.2.5-1 Effects of 2017 court-ordered flushing and emergency dilution flows released from Iron Gate Dam on foothill yellow-legged frog and western pond turtle breeding.
To manage the fish parasite *C. shasta*, mandatory surface flushing flows in the winter-spring, deep flushing flows, and emergency dilution flows would occur in the short-term (0−5 years) in the Middle Klamath River downstream of Iron Gate Dam under the No Project Alternative (see Section 4.2.1.1 *[No Project Alternative] Alternative Description – Summary of Available Hydrology Information for the No Project Alternative*).

The winter-spring surface flushing flow of 6,030 cfs is designed to occur for a 72-hour period between November 1 and April 30 (U.S. District Court 2017). This flow would be sufficient to move surface sediments (i.e., sand and potentially pea-sized gravel). The beginning of the foothill yellow-legged frog breeding season (typically April 22 through early July) overlaps with this flushing flow for about one week (April 22 through April 30). Mean daily flows in April are generally 2,000–3,000 cfs (Figure 3.6-4, Section 3.6.2.2 *Basin Hydrology*). Foothill yellow-legged frogs are known to time their egg-laying with the flow pattern of a given year, initiating egg-laying on the descending limb of the spring hydrograph (i.e., when flows are trending down) (Seltenrich and Pool 2002). If the winter-spring surface flushing flows were to occur early in the foothill yellow-legged frog breeding season, individuals may delay breeding (Gonsolin 2010 and GANDA 2008); otherwise there is a potential for eggs to be scoured, if present, during the winter-spring surface flushing flows.

The deep flushing flows are designed to occur in one 24-hour period at least every other year (U.S. District Court 2017). This one-day flow will consist of an average flow of 11,250 cfs and occur any time between February 15 and May 31. Mean daily flows observed between April and May at Iron Gate Dam are typically between about 2,500–3,500 (Figure 3.6-4 Section 3.6.2.2 *Basin Hydrology*). This deep flushing flow may scour or damage eggs attached to submerged rocks and pebbles during the one-month period that egg-laying overlaps with the deep flushing flows (April 22–May 31). Tadpoles, which hatch between 5–37 days following egg-laying, could be present in May and could be displaced by the deep flushing flows, which would likely result in injury or mortality because the species is not adapted to high flows.

Both the annual surface flushing and deep flushing flows are implemented through flow augmentation when the required flows are not met naturally (i.e., in the case of a dry water year). The flows are timed, where possible, to occur during high precipitation events, in order to reduce the impact on water supplies. This means that any foothill yellow-legged frogs in the area would already be exposed to high flows, though supplementation would make these flows higher. Because the flows are designed to cause bed mobilization, the supplementation would be more likely to cause an impact than the precipitation event alone.

The emergency dilution flows of 3,000–4,000 cfs are designed to occur between April 1 and June 15 if certain disease thresholds are present in the river (U.S. District Court 2017). Existing flows are typically at or above 3,000 cfs for approximately 50 percent of April, 25 percent of May, and 5 percent of June (Figure 3.1-1; Section 3.1.6.2 *Comparison of Klamath River Flows under 2013 Biological Opinion and KBRA*). The emergency dilution flows may scour or damage any eggs that are present between April 22 and June 15, when the flows overlap with the typical foothill yellow-legged frog breeding season. Additionally, direct impacts may result from stranding of eggs if breeding occurs along the river edge during the emergency dilution flows, and the subsequent receding flows reduce the wetted channel and dewatered egg masses. Tadpoles, which hatch between 5 and 37 days following egg-laying, could also be displaced by the emergency dilution flows.

Although survey data are limiting for characterizing the presence of foothill yellow-legged frog in the Klamath River (i.e., this species has not been documented since 1976), occurrences are known in tributaries and presumably individuals have the potential to be present in the mainstem river as well. Due to the listing status of the foothill yellow-legged frog (i.e., State Candidate Threatened), direct mortality or harm to an individual would result in a significant impact. Thus, if eggs, juvenile and/or adult foothill yellow-legged frogs are present in the Middle Klamath River immediately downstream of Iron Gate Dam, direct impacts from scouring and displacement due to the court-ordered flushing and dilution flows may occur. The likelihood of this occurring is not high, because of the lack of certainty that individuals are present in the upper Middle Klamath River and the timing of flow supplementation to occur with natural high flows. However, if present and affected, this would be a significant impact.

Due to the low likelihood of locating eggs during high flow events, mitigation typically employed to reduce impacts to this species (i.e., rescuing and relocating eggs) would be ineffective. Modification of the flows to avoid the potential presence of foothill yellow-legged frog is not feasible. The USBR, which is responsible for the court-ordered flow releases, is a federal agency with a mandate to maximize agricultural deliveries as possible. Therefore, it is not feasible for the agency to adjust its decision-making to accommodate a candidate state-listed and state species of special concern that it does not have a particular obligation to protect. Thus, this would be a significant and unavoidable impact.

Since western pond turtles' nest on land and usually above the floodplain, up to several hundred meters from water (Ashton et al. 1997), there would be no significant impacts to their nests due to the 2017 court-ordered flushing and emergency dilution flows. While the flushing and dilution flows may disperse juvenile and adult western pond turtles, this would be a less than significant impact because although this species is considered an aquatic species, they are known to spend a considerable portion of their lives in upland habitats and may move to upland habitats during high winter flows.

Significance

Significant and unavoidable for foothill yellow-legged frog breeding populations, if present, in the Middle Klamath River immediately downstream of Iron Gate Dam in the short term (0−5 years)

No significant impact for western pond turtle in the Middle Klamath River immediately downstream of Iron Gate Dam in the short term (0−5 years)

4.2.5.4 Wildlife Corridors and Habitat Connectivity

In the short term under the No Project Alternative, the reservoirs and dams would continue to present a barrier to movement for some terrestrial wildlife species (Section 3.5.5.4). Salmon and other fish species would not be able to migrate to reaches upstream of Iron Gate Dam, and thus they would not provide nutrient-rich food for terrestrial species located upstream of Iron Gate Dam. Marine-derived nutrients would not be subsequently deposited into terrestrial habitats and productivity of the terrestrial ecosystem as a whole would not change from existing conditions. There would be no significant impact in the short term compared with existing conditions.

4.2.6 Flood Hydrology

Under the No Project Alternative, there would be no changes to the Lower Klamath Project facilities or operations that would affect flood hydrology in the short term (0−5 years). The existing condition, as described in Section 3.6.2 *Flood Hydrology, Environmental Setting,* would continue. Specifically, there would be no increases in downstream surface water flows during reservoir drawdown that could change flood risks, no changes to flood hydrology due to removal of recreational facilities currently located along the banks of the existing reservoirs, and no changes to flood risks due to downstream sediment deposition as compared with existing conditions, since reservoir drawdown and dam removal would not occur. Thus, there would be no significant impacts to the aforementioned aspects of flood hydrology in the Area of Analysis in the short term (0−5 years) under the No Project Alternative. Potential impacts to the 100-year floodplain inundation extent downstream of Iron Gate Dam, and the potential for dam failure, under the No Project Alternative are discussed further below.

Potential Impact 4.2.6.1 The FEMA100-year floodplain inundation extent downstream from Iron Gate Dam could change due to 2017 flow requirements, potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.

Under the No Project Alternative, the dams would remain in place and the Lower Klamath Project would continue to operate in the short term (0−5 years) under annual licenses issued by FERC. The 2013 BiOp requirements for the upstream USBR Klamath Irrigation Project and the 2017 court-ordered flushing and emergency dilution flows would determine how instream flows through the Lower Klamath Project and releases from Iron Gate Dam are managed (NMFS and USFWS 2013, U.S. District Court 2017).

The 100-year floodplain inundation extent in the Klamath River between RMs 193 and 174 (i.e., from Iron Gate Dam to Humbug Creek) was modeled by USBR (2012), including a "WithDams_100yr" scenario that assumes 2010 BiOp flows and Lower Klamath Project dams remain in place. Floodplain inundation maps illustrating the USBR (2012) model results are presented in Appendix K of this EIR. Because the overall magnitude of the 2010 BiOp flows is consistent with that of the 2013 BiOp flows, and the 2017 court-ordered flushing and emergency dilution flows are within the range of historical Klamath River flows evaluated in 2013 BiOp studies (see also Section 4.2.1.1 *[No Project Alternative] Alternative Description – Summary of Available Hydrology Information for the No Project Alternative*), the 100-year floodplain inundation extent previously modeled by USBR (2012) also serves as the Lower Klamath Project EIR No Project Alternative 100-year floodplain inundation extent. The USBR (2012) 100-year floodplain inundation extent corresponds closely with the current FEMA 100-year flood boundary, however there are some differences between the two modeled inundation extents. These differences are attributable to the use of different hydrographic base data for flood events and the use of enhanced elevation data by USBR (2012). The USBR (2012) analysis is based on LiDAR data with elevation values sufficient to support 2-foot contours along the reach of the Klamath River from Iron Gate Dam (RM 193) to Happy Camp (RM 108.3).

Based on a review of detailed 2010 and 2009 aerial imagery under the USBR (2012) "WithDams_100yr" scenario, 671 structures including mobile homes, houses, farm sheds, bridges, and other features large enough to cast a shadow, are potentially at risk of flooding in a 100-year storm event if the dams remain in place. Many of the structures are mobile homes that move annually or seasonally. Within the FEMA 100-year floodplain, there are 481 structures at risk, including bridges (USBR and CDFG 2012), if the dams remain in place. As described in Section 3.6.5 *Flood Hydrology, Potential Impacts and Mitigation*, the KRRC has determined that there are 34 legally-established habitable structures located within the existing 100-year floodplain between Iron Gate Dam (RM 193) and Humbug Creek (RM 174) (Appendix B: *Definite Plan*). Under the No Project Alternative, these 34 structures would be exposed to a substantial risk of damage or loss involving flooding.

Overall, in the short term (0−5 years), flows under the No Project Alternative would not change from existing adverse conditions, thus the extent of 100-year floodplain inundation in the Klamath River downstream of Iron Gate Dam as modeled by USBR (2012) would not change (see Appendix K for 100-year floodplain inundation maps).

Significance

No significant impact in the short term (0−5 years)

Potential Impact 4.2.6.2 The FEMA 100-year floodplain inundation extent downstream from J.C. Boyle Dam could change due to 2017 flow requirements between the California-Oregon state line and Copco No. 1 Reservoir, potentially exposing people and/or structures to a substantial risk of damage, loss, injury, or death involving flooding.

As part of prior flood-inundation hydrologic and hydraulic modeling conducted for dam removal analyses, USBR (2012) did not conduct 100-yr floodplain mapping within the

Hydroelectric Reach; however, FEMA (2016) mapping includes an existing conditions 100-yr floodplain boundary for the Klamath River, including the Hydroelectric Reach (see Appendix K).

As described for the Proposed Project analysis of Potential Impact 3.6-4 (see Section 3.6.5.2), J.C. Boyle Reservoir provides no storage and the dam typically operates in spill mode at flows above plant capacity (i.e., approximately 6,000 cfs; Table 2-1 in USBR 2012). Existing-conditions peak flows in the Hydroelectric Reach are not attenuated as a result of J.C. Boyle Dam. As is the case for the Middle Klamath River downstream of Iron Gate Dam, flows under the No Project Alternative would not change from existing conditions in the short term (0−5 years), and thus the 100-year floodplain inundation extent in the Klamath River from the Oregon-California state line downstream to Copco No. 1 Reservoir as modeled by FEMA (2016) would also not change from existing conditions (see Appendix K for 100-year floodplain inundation maps). Therefore, there would be no significant impact.

Significance

No significant impact in the short term (0−5 years)

Potential Impact 3.6-6 Dam failure could flood areas downstream of the Lower Klamath Project.

The Lower Klamath Project dams collectively store over 169,000 acre-feet of water when they are full. The dams are inspected regularly and the probability of failure has been found to be low. In the short term (0−5 years), if a dam failed, it could inundate a portion of the downstream watershed. The risk of failure in the next 0−5 years under the No Project Alternative remains the same low risk as under existing conditions. The 0−5 year period is a small fraction of the expected lifetime of the facilities, and the facilities would continue to undergo the same requirements for continuing inspection and maintenance.

Significance

No significant impact in the short term (0−5 years)

4.2.7 Groundwater

Under the No Project Alternative, in the short term (0−5 years), there would be no change in groundwater/ surface water interactions related to the Lower Klamath Project reservoirs as compared with existing conditions, since reservoir drawdown and dam removal would not occur. Groundwater conditions would remain as described in Section 3.7.2 *Groundwater, Environmental Setting*. Thus, there would be no significant impacts to groundwater in the Area of Analysis in the short term (0−5 years) under the No Project Alternative.

4.2.8 Water Supply/Water Rights

Under the No Project Alternative, in the short term (0−5 years), there would be no change in the amount of surface water flow available for diversion under existing water rights in the Middle or Lower Klamath River or Upper Klamath Lake/Keno Reservoir due to operations of the Lower Klamath Project. Thus, except for the changes due to 2017 flow requirements described in Potential Impact 4.2.8-1 below, the existing conditions, as described in Section 3.8.3 *Water Supply/Water Rights, Environmental Setting,* would remain in the short term.

Potential Impact 4.2.8-1 Water availability changes from coordinated operations under 2017 flow requirements
With Iron Gate Dam continuing to block fish passage, it is assumed that the 2017 flushing and emergency dilution flow requirements will continue under the No Project Alternative in the short term. The 2017 flow requirements determine how instream flows through the Lower Klamath Project and releases from Iron Gate Dam are managed (NMFS and USFWS 2013, U.S. District Court 2017; see Section *[No Project] Alternative Description – Summary of Available Hydrology Information for the No Project Alternative*). The 2017 flow requirements require use of more water than the 2013 flow requirements, in that the USBR must guarantee at Iron Gate Dam, annual flushing flows and bi-annual deep flushing flows. Additionally, USBR must maintain an additional 50,000 acre feet of water until approximately June 15 annually, as a reserve in case emergency dilution flows are needed. The amount of water required to maintain the flow requirements is not fixed, because the requirements work in tandem with available high flows. Thus, the amount of water that USBR must withhold from deliveries in order to ensure the flow minimums are met will vary each year. Additionally, in some years, the 50,000 acre-feet of water held in reserve for dilution flows will be available for delivery to the Klamath Irrigation Project later in the year, while in other years it will not. While it is not possible to quantify the reduction in water available for Klamath Irrigation Project deliveries, it is reasonable to assume that there will be some level of reduced deliveries in most, if not all, years. In 2018, the amount of Klamath Irrigation Project Supply water required to meet 2017 flow requirements was 76,713 acre-feet. As noted in Potential Impact 3.8-2, the potential for the Lower Klamath Project dams to somewhat ameliorate reductions in water deliveries would be uncertain in light of stated operational changes. Despite this uncertainty, there would remain some potential for coordinated operations to reduce the amount of supply by up to 20,000 acre-feet in drought situations. As discussed in Section 3.8 *Water Supply/Water Rights*, coordinated efforts do not affect releases downstream of Iron Gate Dam, and therefore do not impact water rights downstream. The Lower Klamath Project is not required to operate in such a manner as to extend USBR deliveries.

The potential for coordinated operations under the 2017 flow requirements has no significant impact as compared to the exiting condition.

Significance
No significant impact in the short term (0−5 years)

4.2.9 Air Quality

In the short term under the No Project Alternative, there would be no additional construction above existing conditions. Therefore, unlike under the Proposed Project (Potential Impacts 3.9-1−3.9-6), short-term impacts associated with increased air emissions due to dam removal and construction activities would not occur. Conditions would remain consistent with the operation of existing Lower Klamath Project facilities and there would be no air quality impacts in the reasonably foreseeable period (0−5 years), relative to existing conditions described in Section 3.9.3 *Air Quality, Environmental Setting*.

4.2.10 Greenhouse Gas Emissions

In the short term under the No Project Alternative, there would be no change to the level of power production, and no additional construction above existing conditions, described in Section 3.10.2 *Greenhouse Gas Emissions, Environmental Setting*. Therefore, unlike under the Proposed Project (Potential Impacts 3.10-1–3.10-5), there would be no impacts related to greenhouse gas emissions in the short term (0−5 years) relative to existing conditions.

4.2.11 Geology, Soils, and Mineral Resources

In the short term under the No Project Alternative (0−5 years), there would be no changes in the operations or facilities of the Lower Klamath Project, so the existing conditions would continue, as described in Section 3.11 *[Geology, Soils, and Mineral Resources] Environmental Setting*. Specifically, there would be no changes in geologic hazards, the hillslope stability of reservoir slopes, or the stability of the earthen dam embankments at J.C. Boyle or Iron Gate dams as compared with existing conditions, since reservoir drawdown and dam removal would not occur. There would also be no soil disturbance associated with dam removal construction activities. In the short term, the No Project Alternative would continue existing operations and, therefore, would have no significant impact on the aforementioned aspects of geology and soils within the Hydroelectric Reach compared to existing conditions.

Since reservoir drawdown and dam removal would not occur, erosion of the sediment deposits stored within the Lower Klamath Project reservoirs, downstream sedimentation, and downstream bank erosion due to the release of these sediment deposits would not occur, and there would be no significant impact . Rather, in the short term under the No Project Alternative, J.C. Boyle, Iron Gate, and Copco No. 1 reservoirs would continue to trap sediment at rates similar to historical rates. Based on historical sediment trapping rates and sediment levels in each reservoir, an estimated 2.4 million cubic yards of sediment would be deposited in the reservoirs over the next 5 years. Studies indicate that the trapping efficiency of J.C. Boyle Dam may decrease slightly as the reservoir capacity decreases, but this is not expected to be a factor over the next five years (USBR 2012).

The continued interception of sand, gravel and coarser sediment supplied by sources upstream of Iron Gate Dam would continue to coarsen the channel bed and reduce the size and frequency of mobile coarse sediment deposits in the Hydroelectric Reach and in the Middle Klamath River from Iron Gate Dam to approximately the Scott River, limiting the amount and quality of spawning gravel deposits in these reaches (see also Appendix F). While the winter-spring surface flushing flows and deep flushing flow requirements at Iron Gate Dam (Section 4.2.1.1 *[No Project Alternative] Alternative Description – Summary of Available Hydrology Information for the No Project Alternative)* would increase the mobility of existing surficial fine sediment deposits and infilled fine sediment from the armor layer, with potential for slight mobilization of the armor layer in some locations, new sediment supply would not occur. Overall, maintenance of static channel features would represent no change from existing adverse conditions for the Middle Klamath River between Iron Gate Dam and the confluence with the Scott River.

In the short term under the No Project Alternative, the presence of Copco No. 1 Reservoir would continue to prevent access to the known mineral resource of diatomite beds located at the southern shore near Copco No. 1 Dam (see Section 3.11.2.1 *Regional Geology, Mineral Resources* and Potential Impact 3.11-7). Because of their location in the reservoir and existing erosion resulting from wave action, the diatomite resources are currently inaccessible for extraction purposes. In the short term there would be no change from existing conditions with respect to the diatomite beds under the No Project Alternative because the resources would continue to be inaccessible. The No Project Alternative would have no significant impact on mineral resources relative to existing conditions in the short term.

4.2.12 Historical Resources and Tribal Cultural Resources

In the short term under the No Project Alternative, dam removal construction and reservoir drawdown would not occur, and Lower Klamath Project operations would continue and there would be no change from existing conditions for historical resources and tribal cultural resources, as described in section 3.12.2 *Historical Resources and Tribal Cultural Resources*. Thus, there would be no construction- or restoration-related impacts to known, or as yet unknown, tribal cultural resources (Potential Impacts 3.12-1, 3.12-4, and 3.12-5), no potential shifting and exposure of existing tribal cultural resources within the Lower Klamath Project reservoir footprints or located along the Klamath River (Potential Impacts 3.12-2, 3.12-3, 3.12-7), nor increased potential for looting (Potential Impacts 3.12-6, 3.12-8), since reservoir drawdown would not occur. The potential for impacts to tribal cultural resources due to wave erosion in the annual reservoir fluctuation zone would continue, as described under Potential Impacts 3.12-2 and 3.12-8 of the Proposed Project. The potential beneficial effects on the Klamath Cultural Riverscape related to Proposed Project implementation (including the beneficial effects of the contributing factors of fisheries improvement and improved cultural use of riverine waters through water quality improvements—see Potential Impacts 3.12-9 and 3.12-10) would not occur under the No Project Alternative. Additionally, there would be no impacts to Copco No. 1 Dam, Copco No. 2 Dam, and Iron Gate Dam, their associated hydroelectric facilities, and the Klamath River Hydroelectric Project District (Potential Impact 3.12-11), because the Lower Klamath Project would remain in place. Potential impacts to submerged historic-period archaeological resources (Potential Impacts 3.12-12 through 3.12-16) within the reservoir footprints and along the Klamath River would not occur. Overall, conditions for historical resources and tribal cultural resources would remain consistent with existing conditions, and there would be no significant impacts in the short-term period (0−5 years).

4.2.13 Paleontologic Resources

Under the No Project Alternative, there would be no change in construction or operations of the facilities that could affect paleontologic resources in the short term (0−5 years), thus there would be a continuation of existing conditions as described in 3.13.2 *Paleontologic Resources, Environmental Setting*. Specifically, there would be no downcutting or erosion of the Hornbrook Formation located downstream of Iron Gate Dam due to drawdown of the Lower Klamath Project reservoirs. Therefore, relative to existing conditions, there would be no significant impact to paleontologic resources.

4.2.14 Land Use and Planning

In the short term under the No Project Alternative, there would be no change to ongoing project operations, practices, or land uses, or facilities that would affect Land Use and Planning; therefore, the existing condition would continue, as described in Section 3.14.2 *Land Use and Planning, Environmental Setting.* In the short term under the No Project Alternative, there would be no additional construction above existing conditions, and no changes of land use under KHSA section 7.6.4, which relates to disposition of Parcel B lands. Specifically, there would be no significant impacts to established communities associated with dam removal, or conflicts with applicable land use plans, policies, or regulations. In contrast to the Proposed Project, road maintenance changes would not occur, and fencing would not be needed as the Lower Klamath Project reservoirs would remain in place. Conditions would remain consistent with the existing operation of Lower Klamath Project facilities.

4.2.15 Agriculture and Forestry Resources

In the short term under the No Project Alternative, agriculture and forestry resource management would continue to be implemented as per existing conditions described in Section 3.15.2 *Agriculture and Forestry Resources, Environmental Setting*. No farmland would be directly or indirectly converted to non-agricultural use. No forest lands would be converted to non-forest use and, in general, the No Project Alternative would maintain the status quo with regard to Williamson Act contracts and zoning. Thus, there would be no reasonably foreseeable short-term (0−5 years) impacts to agriculture and forestry resources relative to existing conditions.

4.2.16 Population and Housing

In the short term under the No Project Alternative, there would be no changes that would alter the existing trends in population and housing as described in Section 3.16.2 *Population and Housing, Environmental Setting*. No short-term potential impacts to population and housing associated with construction for dam removal would occur. Thus, unlike under the Proposed Project (Potential Impacts 3.16-1 and 3.16-2), there would be no influx of temporary workers relative to the existing conditions. Population and housing would follow current trends, and there would be no significant impact.

4.2.17 Public Services

In the short term under the No Project Alternative, there would be no increase in construction related to the Lower Klamath Project facilities in the reasonably foreseeable period (0−5 years). Thus, the potential public services impacts associated with dam removal and construction activities under the Proposed Project would not occur for the No Project Alternative, and the existing condition as described in Section 3.17.2 *Public Services, Environmental Setting* would continue. Relative to existing conditions, public services response times for emergency fire, police, and medical services would not increase due to construction and demolition activities, there would be no increased risk of wildfires and need for firefighting measures due to construction and demolition activities, and there would be no potential effects on schools services and facilities. Conditions would remain consistent with the existing operation of Lower Klamath Project facilities, and there would be no significant impact to public services.

4.2.18 Utilities and Service Systems

In the short term under the No Project Alternative, there would be no increase in construction related to operations of the Lower Klamath Project facilities in the reasonably foreseeable period (0−5 years). Therefore, the potential Utilities and Service Systems impacts associated with dam removal construction activities would not occur, and the existing condition as described in Section 3.18 *Utilities and Service Systems, Environmental Setting* would continue. Relative to existing conditions, there would be no need for construction of new wastewater treatment facilities, or expansion of existing facilities to serve new recreational facilities or construction work crews, no need for construction of new stormwater drainage facilities, or expansion of existing facilities, no generation of large volumes of waste due to dam removal and construction activities requiring landfill capacity. Conditions would remain consistent with the operation of existing Lower Klamath Project facilities, and there would be no significant impact to utilities and service systems in the short term.

4.2.19 Aesthetics

Under the No Project Alternative, the operations and facilities of the Lower Klamath Project would remain the same for the short term. Therefore, visual impacts resulting from project construction and reservoir drawdown would not occur, and the existing condition would continue, as described in Section 3.19.2 *Aesthetics, Environmental Setting*. There would be no loss of open water vistas, no changes in flows and channel morphology, no changes in visual water quality due during periods of elevated SSCs, and no exposure of bare areas of sediment and rock, all due to reservoir drawdown. In addition, there would be no long-term visual changes from either removal of the Lower Klamath Project facilities, or construction of new infrastructure and improvements to existing infrastructure. There would also be no construction equipment, staging areas, and demolition areas that could detract from the natural surroundings, and no nighttime construction or security lighting that would adversely affect nighttime views under the No Project Alternative. The existing Lower Klamath Project facilities and their operations are already a part of the environmental baseline. Aesthetic conditions would remain consistent with surrounding recreational, agricultural, open space and rural residential land uses, and visual presence of the Lower Klamath Project facilities, and there would be no significant impacts to aesthetics in the short term (0−5 years).

4.2.20 Recreation

In the short term under the No Project Alternative, there would be no change to existing recreation facilities and opportunities, as dam removal construction, recreation facilities removal (and potential construction of additional facilities) and reservoir drawdown would not occur. The existing condition as described in Section 3.20.2 *Recreation, Environmental Setting,* would continue. Thus, there would be: no restrictions, noise, dust, and/or sediment release due to dam removal activities that would impact existing recreational facilities; no changes to, or loss of, local or regional reservoir-based recreation activities and facilities due to reservoir drawdown; no increase in the use of regional recreational facilities due to the loss facilities at the Lower Klamath Project reservoirs; and no construction of new or expanded recreational facilities due to dam removal. There would also be no changes to, or loss of, river conditions that support whitewater boating, or other river-based recreation, including fishing; and no potential impacts to Wild and Scenic River resources, designations, or eligibility for listing due to dam removal activities. Conditions for recreation would remain consistent with existing conditions, and there would be no significant impact in the short term (0−5 years) .

4.2.21 Hazards and Hazardous Materials

In the short term under the No Project Alternative, there would be no change to the current operations of the Lower Klamath Project, and therefore no change related to hazards and hazardous materials. Therefore, the existing condition as described in Section 3.21.2 *Hazards and Hazardous Materials, Environmental Setting,* would continue. There would not be significant dam removal and construction impacts associated with the transport and use of hazardous materials during project construction activities, and there would not be a need for implementation of an emergency response plan associated with construction activities. The existing hazardous materials that have been identified at the Lower Klamath Project dams and associated facilities would remain. Since reservoirs would remain, there would be no increased risk from wildfires under the No Project Alternative. Conditions would remain consistent with the operation of existing Lower Klamath Project facilities, and there would be no significant impacts related to hazards and hazardous materials in the short term (0−5 years), as compared to existing conditions.

4.2.22 Transportation and Traffic

In the short term under the No Project Alternative, there would be no change to the operations or facilities of the Lower Klamath Project that would potentially impact transportation and traffic, and therefore the existing conditions would continue, as described in Section 3.22.2 *Transportation and Traffic, Environmental Setting*. No potential impacts associated with increased vehicular traffic, or increases in potential conflicts with vehicular and non-vehicular traffic, as part of construction-related activities would occur. No improvements to roads, bridges or culverts would occur beyond the typical levels of maintenance already occurring under existing conditions. Conditions would remain consistent with the operation of existing Lower Klamath Project facilities and there would be no significant impacts to Transportation and Traffic in the short term (0−5 years) compared with existing conditions.

4.2.23 Noise

In the short term under the No Project Alternative, there would be no change to the operations or facilities of the Lower Klamath Project that would potentially impact noise. Therefore, the existing condition as described in Section 3.23.2 *Noise, Environmental Setting,* would continue. No potential impacts associated with noise and vibration levels from dam removal construction and reservoir restoration would occur. Therefore, there would be no significant impact related to noise under the No Project Alternative compared with existing conditions.

4.3 Partial Removal Alternative

4.3.1 Introduction

4.3.1.1 Alternative Description

In the Partial Removal Alternative, sufficient portions of J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dam complexes would be removed to ensure a free-flowing Klamath River and year-round volitional fish passage under all river stages and flow conditions in the Hydroelectric Reach. Ancillary facilities associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dam complexes that do not affect Klamath River flows or volitional fish passage would be abandoned in place. In general, the ancillary facilities to be retained under the Partial Removal Alternative include the Copco No. 1 Powerhouse, penstocks, and intake structure, the Copco No. 2 Powerhouse, steel penstocks and supports, and intake structure, and the lower portion of the Iron Gate Powerhouse (Table 4.3-1, Table 4.3-3, Table 4.3-5). The mechanical and electrical equipment associated with each of the powerhouses would also remain. Penstock openings and powerhouse intakes would be sealed and security fences would be installed around the remaining structures to ensure public safety. Some of the remaining features would likely require ongoing maintenance, including periodic repair and replacement of fencing and repainting/recoating facilities. Detailed lists of features to be retained and new or different construction activities that would be undertaken for the Partial Removal Alternative as compared with the Proposed Project are presented in Table 4.3-2 and Table 4.3-4, and Table 4.3-6.

Other than the aforementioned portions of the Lower Klamath Project dam complexes that would remain under this Partial Removal Alternative, all other aspects would occur as described under the Proposed Project: dam and powerhouse deconstruction, reservoir drawdown, erosion of reservoir sediment deposits during drawdown, restoration within the reservoir footprint, restoration of upland areas, hatchery operations, City of Yreka water supply pipeline relocation, aquatic and terrestrial resource measures, road and bridge improvements/replacements, culvert replacements, recreation facilities removal, traffic management, groundwater well monitoring and replacement, fire management, hazardous material management, emergency response, and noise and vibration control measures (see also Section 2.7 *Proposed Project*).

Table 4.3-1. Copco No. 1 Dam and Powerhouse Removal Under the Partial Removal Alternative.

Feature[1]	National Register Eligibility Recommendation and Reference		Proposed Project (see also Table 2.7-2)	Partial Removal Alternative
	Kramer (2003)	2012 KHSA EIS/EIR		
Concrete Dam	Historic Contributing	Historic Contributing	Remove to elevation 2,463.5 feet, which is 20 feet below original river channel bottom	Same as the Proposed Project
Spillway Gates and Operators, Deck, Piers	No information	No information	Remove	Same as the Proposed Project
Penstocks	Historic Contributing	Historic Contributing	Remove	**Seal openings but retain penstocks, install security fence[2]**
Powerhouse Intake Structure	No information	No information	Remove	**Seal openings but retain powerhouse intake structure, install security fence[2]**
Gate Houses on Right Abutment	Historic Contributing	Historic Contributing	Remove	Same as the Proposed Project [3]
Diversion Control Structure	No information	No information	Remove	Same as the Proposed Project[4]
Tunnel Portals[5]	No information	No information	Retain the tunnel, plug the tunnel portals with reinforced concrete[5]	Same as the Proposed Project[5]
Powerhouse (including mechanical and electrical equipment)	Historic Contributing	Historic Contributing	Remove	**Retain, install security fence. Powerhouse would remain in the 100-year floodplain[2,6]**
Powerhouse Hazardous Materials (including transformers, batteries, insulation)	No information	No information	Remove	Same as the Proposed Project
Four 69-kv Transmission Lines (3.03 miles total) (including poles and transformers)	No information	No information	Remove	Same as the Proposed Project
Switchyard	No information	No information	Remove	Same as the Proposed Project
Warehouse and Residence[7]	Historic Contributing	Historic Contributing	Remove	Same as the Proposed Project

5 Feature as presented in Appendix B: *Definite Plan – Table 5.3-1*.

6 Some of the features proposed to be retained under the Partial Removal Alternative may have coatings that contain heavy metals (such as the penstocks) and that could be exposed during or following construction activities. These features would require preservation under the Partial Removal to reduce the risk of environmental contamination.

7 While it would be possible to partially remove the gate houses, they are likely to be fully removed to facilitate construction access (e.g., to allow a large crane to access the site). For the purposes of this CEQA analysis, it is assumed that the gate houses would be fully removed.

8 The existing diversion control structure includes gate hoists, stems, and wire ropes, which would be demolished along with unstable concrete as part of modifying the diversion structure prior to reservoir drawdown. Proposed features to modify the diversion control structure (i.e., new downstream tunnel gate and portal, new upstream blind flanges) to facilitate reservoir drawdown would be removed as part of dam deconstruction activities.

9 Refers to the Diversion Tunnel shown in Figure 2.7-2.

10 Retention of the Copco No. 1 Powerhouse under the Partial Removal Alternative would require the structure to be sealed and fenced, unless developed for public benefit as a historic structure (using an alternative funding source).

11 Refers to the Maintenance Building and the North and South Residences shown in Figure 2.7-2.

Table 4.3-2. Copco No. 1 Features[1] to be Retained and New or Different Construction Activities Under the Partial Removal Alternative as Compared with the Proposed Project.

Retain concrete intake structure on right abutment	Retain station service 600-volt switchgear
Retain diversion tunnel control structure concrete	Retain unit and plant control switchboard
Retain three sections of 23-foot by 72-inch diameter steel lining	Retain raceways, conduit and cable
Retain three 72-inch butterfly valves	Retain miscellaneous power and control boards
Retain powerhouse concrete down to top of rock under the powerhouse	Retain indoor, oil-filled, step-up, 1-phase, 5000 kilo-volt ampere (kVA) transformers
Retain powerhouse structural steel	Retain seven 40-ton indoor travelling crane motors
Retain two governor oil systems	Retain 40-ton indoor travelling crane control
Retain cooling water and bearing oil systems	Retain 40-ton indoor travelling crane festoon cable
Retain four horizontal tandem Francis turbines	Retain four 15-ton overhead crane motors
Retain two 40-ton indoor travelling cranes	Retain 15-ton overhead crane control
Retain compressed air system	Retain 15-ton overhead crane festoon
Retain two CO2 systems	Retain concrete items associated with 10 foot-diameter penstock
Retain plant water and fire protection	No plugging of the 14-foot diameter penstock with concrete
Retain transformer oil fire protection	Retain 8 screens
Retain unwatering piping	Retain 8 water gates
Retain drainage piping	Retain three 30-inch diameter by 25-foot stand pipes
Retain horizontal 12 mega-volt ampere (MVA) generator	Retain 14-foot diameter penstock pipe
Retain excitation equipment for 12 MVA generator	Retain 10-foot diameter penstock pipe
Retain surge protection equipment for 12 MVA generator	Seal openings in the penstocks, powerhouse intake structure, and powerhouse
Retain neutral grounding equipment for 12 MVA generator	Install security fencing around penstocks, powerhouse intake structure, and powerhouse

[1] Feature description using information presented in Appendix B: *Definite Plan – Appendix P – Attachments A.1 and A.2.*

Table 4.3-3. Copco No. 2 Dam and Powerhouse Removal Under the Partial Removal Alternative.

Feature[1]	National Register Eligibility Recommendation and Reference		Proposed Project (see also Table 2.7-4)	Partial Removal Alternative
	Kramer (2003)	2012 KHSA EIS/EIR		
Concrete Dam	Historic Contributing	Historic Contributing	Remove	Same as Proposed Project
Spillway Gates, Structure	Historic Contributing	No Information	Remove	Same as Proposed Project
Power Penstock Intake Structure and Gate	Historic Contributing	Historic Contributing	Remove	**Seal openings but retain power penstock intake structure and gate, install security fence[2]**
Tunnel Portals[3]	Historic Contributing	Historic Contributing	Retain the tunnel, plug the tunnel portals with reinforced concrete[2]	**Same as Proposed Project but retain and close intake structure gate[2]**
Embankment Section and Right Sidewall	No Information	No Information	Remove	Same as Proposed Project
Basin Apron and End Sill	No Information	No Information	Remove	Same as Proposed Project
Remnant Cofferdam Upstream of Dam	Historic Contributing	Historic Contributing	Remove	Same as Proposed Project
Wood-stave Penstock	Historic Contributing	Historic Contributing	Remove	Same as Proposed Project
Concrete Pipe Cradles	No Information	No Information	Remove	Same as Proposed Project
Steel Penstock, Supports, Anchors	Historic Contributing[4]	Historic Contributing[4]	Remove	**Seal openings but retain penstock, supports, and anchors, install security fence[2]**
Powerhouse (including mechanical and electrical equipment)	Historic Contributing	Historic Contributing	Remove	**Retain, seal openings, install security fence[2,5]**
Powerhouse Hazardous Materials (including transformers, batteries, insulation)	No Information	No Information	Remove	Same as Proposed Project
Powerhouse Control Center Building and Maintenance Building	Non-Contributing	No Information	Remove	Same as Proposed Project
Oil and Gas Storage Building	Historic Contributing	No Information	Remove	Same as Proposed Project
69-kV Transmission Line, 0.14 mile	No Information	No Information	Remove	Same as Proposed Project

Feature[1]	National Register Eligibility Recommendation and Reference		Proposed Project (see also Table 2.7-4)	Partial Removal Alternative
	Kramer (2003)	2012 KHSA EIS/EIR		
Switchyard	Non-Contributing[6]	No Information	Retain – the switchyard is not part of the Proposed Project	Same as Proposed Project
Tailrace Channel	No Information	No Information	Backfill[2]	Same as Proposed Project[2]
Copco Village, Copco No. 2 Cookhouse/Bunkhouse	Historic Contributing	No Information	Remove	Same as Proposed Project
Copco Village, Bungalow Housing (bungalow and garage)	Historic Contributing	No Information	Remove	Same as Proposed Project
Copco Village (including modern bunkhouse, garage/ storage building, three modular houses, four ranch-style houses, and schoolhouse/community center)[7]	Non-Contributing	No Information	Remove	Same as Proposed Project

1 Feature as presented in Appendix B: *Definite Plan – Table 5.4-1*.
2 Some of the features proposed to be retained under the Partial Removal Alternative may have coatings that contain heavy metals (such as the penstocks) and that would be exposed during or following construction activities. These features would require preservation under the Partial Removal to reduce the risk of environmental contamination.
3 Refers to Conveyance Tunnel and Overflow Spillway Tunnel shown in Figure 2.7-2.
4 Supports and anchors not specified as part of the National Register Eligibility Recommendation.
5 Located within the FEMA designated 100-year floodplain under existing conditions (FEMA 2011a).
6 Switchyard labeled as the Copco No. 2 Substation in Kramer (2003).
7 For the purposes of this CEQA analysis, Copco Village facilities also includes the water tower shown in Figure 2.7-2.

Table 4.3-4. Copco No. 2 Features[1] to be Retained and New or Different Construction Activities Under the Partial Removal Alternative as Compared with the Proposed Project.

No removal of water from behind tailrace cofferdam	Retain indoor, vertical alternating current generator
No dewatering behind tailrace cofferdam	Retain excitation equipment for 15 milli-volt ampere (MVA) generator
No construction of embankment cofferdam across tailrace	Retain surge protection equipment for 15 MVA generator
Retain right abutment random fill	Retain neutral grounding equipment for 15 MVA generator
Retain right abutment hand-placed riprap	Retain switchgear for equipment for 15 MVA generator
Retain right abutment gunite curtain wall	Retain station service 600-volt switchgear
Retain copper shingles from roof of powerhouse	Retain unit and plant control switchboard
Retain powerhouse concrete down to spring-line of turbine	Retain battery system
Retain structural steel items associated with powerhouse	Retain raceways, conduit and cable
Retain shop building	Retain miscellaneous power and control boards
Retain two governor oil systems	Retain seven 40-ton travelling crane motors hoists
Retain cooling water and bearing oil systems	Retain 40-ton travelling crane controls
Retain oil/water separator tank and piping	Retain 40-ton travelling crane festoon cables
Retain 12 cast iron columns	Retain intake structure concrete
Retain two Francis turbines	Retain concrete items associated with 16-foot inner diameter wood penstock
Retain two 40-ton indoor cranes	Retain concrete items associated with penstocks
Retain compressed air systems	Retain steel caterpillar gate
Retain two CO2 systems	Retain steel trash rack and trash rake
Retain plant water and fire protection	Retain steel stop logs and slots for intake
Retain transformer oil fire protection	Retain penstock after bifurcation to butterfly
Retain unwatering piping	Retain bifurcated vent pipes and support
Retain drainage piping	Retain two 138-inch butterfly valves
Seal openings in the penstocks, powerhouse intake structure, and powerhouse	Install security fencing around penstocks, powerhouse intake structure, and powerhouse

1 Feature description using information presented in Appendix B: *Definite Plan – Appendix P – Attachments A.1 and A.2.*

Table 4.3-5. Iron Gate Dam and Powerhouse Removal Under the Partial Removal Alternative.

Feature[1]	National Register Eligibility Recommendation and Reference		Proposed Project (see also Table 2.7-6)	Partial Removal Alternative
	Kramer (2003)	2012 KHSA EIS/EIR		
Embankment Dam, Cutoff Walls	Non-Contributing	Historic Contributing	Remove	Same as Proposed Project
Penstock Intake Structure and Footbridge	Non-Contributing	Historic Contributing	Remove	Same as Proposed Project
Penstock	Non-Contributing	Historic Contributing	Remove	Same as Proposed Project
Water Supply Pipes and Aerator	No Information	No Information	Remove	Same as Proposed Project
Spillway Structure	Non-Contributing	Historic Contributing	Retain and bury to extent practicable[2]	Same as Proposed Project[2]
Powerhouse (including mechanical and electrical equipment)	Non-Contributing	Historic Contributing	Remove	**Retain lower portion of the powerhouse and seal openings, remove upper portion of the powerhouse[3]**
Powerhouse Hazardous Materials (transformers, batteries, insulation)	No Information	No Information	Remove	Same as Proposed Project
Powerhouse Tailrace Area	No Information	No Information	Backfill[2]	Same as Proposed Project[2]
Fish Facilities on Dam (fish ladder and trapping and holding facilities)	Non-Contributing	Historic Contributing	Remove	Same as Proposed Project
Fish Hatchery	Non-Contributing	No Information	Fish ladder and holding tanks at the toe of the dam would be removed, as would the cold-water supply for the hatchery; these facilities would be relocated such that the hatchery remains operational for eight years after the removal of Iron Gate Dam (see also Section 2.7.6)	Same as Proposed Project

Feature[1]	National Register Eligibility Recommendation and Reference		Proposed Project (see also Table 2.7-6)	Partial Removal Alternative
	Kramer (2003)	2012 KHSA EIS/EIR		
Switchyard	No Information	No Information	Remove	Same as Proposed Project
69-kV Transmission Line, 0.5 mi	No Information	No Information	Remove	Same as Proposed Project
Diversion Tunnel Intake Structure and Footbridge	Non-Contributing	No Information	Remove	Same as Proposed Project
Diversion Tunnel and Portals	Non-Contributing	No Information	Retain the tunnel, plug the tunnel portals with reinforced concrete[2]	Same as Proposed Project[2]
Diversion Tunnel Control Tower, Hoist, and Gate	Non-Contributing	No Information	Remove above finished-grade portion and retain below finished-grade portion[2]	Same as Proposed Project[2]
Additional Ancillary Facilities (e.g., communication buildings, restrooms and two residences)[4]	Non-Contributing	Historic Contributing[5]	Remove	Same as Proposed Project

[1] Feature as presented in Appendix B: *Definite Plan – Table 5.5-1*.
[2] Some of the features proposed to be retained under the Partial Removal Alternative may have coatings that contain heavy metals (such as the penstocks) and that could be exposed during or following construction activities. These features would require preservation under the Partial Removal to reduce the risk of environmental contamination.
[3] Located within the FEMA designated 100-year floodplain under existing conditions (FEMA 2011b).
[4] These facilities are discernible in Figure 2.7-4 although they not itemized in Appendix B: *Definite Plan – Table 5.5-1.*
[5] National Register Eligibility Recommendation only applies to the communication building and restroom. No recommendation made for the two residences.

Table 4.3-6. Iron Gate Features[1] to be Retained and New or Different Construction Activities Under the Partial Removal Alternative as Compared with the Proposed Project.

No furnishing, installing, and then removing temporary air vent hose from barge to diversion tunnel intake structure	Retain drainage piping
No removal of water from behind tailrace cofferdam	Retain transformer oil and fire protection
No dewatering behind tailrace cofferdam	Retain compressed air system
No construction of embankment cofferdam across tailrace	Retain outdoor horizontal generator
Retain powerhouse concrete	Retain excitation equipment for 18.975 milli-volt ampere (MVA) generator
Retain turbine unit	Retain surge protection equipment for 18.975 MVA generator
Retain draft tube bulkheads	Retain neutral grounding equipment for 18.975 MVA generator
Retain crane	Retain station service 600-volt switchgear
Retain governor oil system	Retain unit and plant control switchboard
Retain bearing oil system and cooling water system	Retain raceways, bus, conduit and cable
Retain CO2 systems	Retain miscellaneous power and control boards
Retain plant water and fire protection	Retain 3-phase, 275-kilo-volt ampere (kVA) transformer
Retain sump pumps	Retain governor oil pump motors
Retain pumps	Seal openings in the penstocks, powerhouse intake structure, and powerhouse
Retain exposed piping around the powerplant	Install security fencing around penstocks, powerhouse intake structure and powerhouse
Retain unwatering piping	

[1] Feature description using information presented in Appendix B: *Definite Plan – Appendix P – Attachments A.1 and A.2.*

4.3.1.2 Alternative Analysis Approach

Like the Proposed Project analysis in Section 3, the potential impacts of the Partial Removal Alternative are analyzed in comparison to existing conditions. Unless otherwise indicated, the significance criteria, area of analysis, environmental setting, and impact analysis approach, including consideration of existing local policies, for all environmental resource areas under the Partial Removal Alternative are the same as those described for the Proposed Project (see Section 3.1 *Introduction* and individual resource area subsections in Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures*). Most potential impacts for each environmental resource area are analyzed both in the short term and the long term, and unless otherwise indicated, use the same definitions of short term and long term as described for each resource area analyzed for the Proposed Project.

Based upon the detailed list of features that would be retained under the Partial Removal Alternative (Table 4.3-2 and Table 4.3-4, Table 4.3-6), the analysis of this alternative assumes that deconstruction techniques are the same as for the Proposed Project, with no specialized means or methods necessary. The analysis also assumes that the Partial Removal Alternative would use the same equipment as the Proposed Project. This alternative would require time to secure retained facilities by removing hazardous materials and installing fences and similar security features to prevent unwanted entry, such that the Partial Removal Alternative would adhere to the same schedule as the Proposed Project (Table 2.7-1).

The Definite Plan (Appendix B: *Definite Plan*) does not describe how openings in the penstocks, powerhouse intake structures, and powerhouse would be sealed, or how much security fencing would be needed under the Partial Removal Alternative. This alternative assumes that penstock openings would be sealed with reinforced concrete to eliminate trespass concerns.
Assuming a 100-foot buffer around each of the retained structures, approximately 3,100 linear feet of fencing would be installed. There would be an estimated six openings to seal for the three Copco No. 1 steel penstock pipes, and an estimated two openings to seal for the Copco No. 2 steel penstock. There would be an unknown number of openings to seal for the powerhouses; however, combined with the penstock openings, the total amount of area to be sealed and the construction-related effort to do so, including waste disposal and materials import, would be considerably less than the construction-related effort saved by not demolishing and processing waste from the numerous features listed in Table 4.3-2, Table 4.3-4, and Table 4.3-6, and in particular the multiple 40-ton travelling indoor cranes and 15-ton overhead cranes from Copco No. 1 and Copco No. 2 powerhouses, approximately 1,400 feet of steel penstocks for Copco No. 1 and Copco No. 2 powerhouses, and the concrete for the bottom portion of the Iron Gate Powerhouse.

This analysis also assumes that excavation and cut/fill activities associated with the Partial Removal Alternative would be lower than the Proposed Project because the footprint on which equipment would be operating is smaller (Appendix N – *Section N.3.2 Emissions from the Partial Removal Alternative*). However, emissions associated with the other construction-related activities would be relatively unaffected because the peak number of truck trips, construction equipment, and temporary workers would not substantially change between the Proposed Project and this alternative because the remaining structures will require sealing of penstocks, intake structures, and powerhouses, and security fence installation.

4.3.2 Water Quality

The Partial Removal Alternative would have the same level of significance for potential impacts on water quality as those identified under the Proposed Project. While partial removal of the Lower Klamath Project dam complexes would reduce construction activities due to some structures remaining in place (Table 4.3-1 through Table 4.3-6), the majority of the Lower Klamath Project dam complexes would still be removed under this alternative, including the entirety of each dam. Sealing of openings in the penstocks, powerhouse intake structures, and powerhouses, and installation of security fencing around the remaining features would require some degree of materials import (i.e., sealing materials, fencing). Compared with the Proposed Project, the same degree of mobilization of Lower Klamath Project reservoir sediment deposits would occur. Although there would be a decrease in construction-related activities under the Partial Removal Alternative due to some Lower Klamath Project structures remaining in place, the degree of difference would not be sufficient to significantly reduce water quality impacts identified for the Proposed Project or any potential mitigation measures. Water quality impacts under the Partial Removal Alternative (i.e., water temperature-related: Potential Impact 3.2-1 and 3.2-2; suspended sediment-related: Potential Impact 3.2-3 through to 3.2-6; nutrient-related: Potential Impact 3.2-7 and 3.2-8; dissolved oxygen-related: Potential Impact 3.2-9 and 3.2-10; pH-related: Potential Impact 3.2-11; chlorophyll-a and algal toxins-related: Potential Impact 3.2-12; and inorganic and organic contaminant-related: Potential Impact 3.2-13 to 3.2-16; general water quality-related: Potential Impact 3.2-17 and 3.2-18) would be the same as the Proposed Project.

4.3.3 Aquatic Resources

4.3.3.1 Key Ecological Attributes

Although there would be a decrease in construction-related activities under the Partial Removal Alternative due to several of the Lower Klamath Project structures remaining in place (Table 4.3-1 through Table 4.3-6), the degree of difference would not be sufficient to significantly reduce the potential effects of dam removal on key aquatic ecological attributes (e.g., suspended sediment, bedload, water quality, disease and parasites, algal toxins, aquatic habitat, and instream flows). Thus, effects on key ecological attributes under the Partial Removal Alternative would be indistinguishable from those described for the Proposed Project.

4.3.3.2 Aquatic Resource Impacts

Like under the Proposed Project, reservoir drawdown associated with dam removal under the Partial Removal Alternative could directly impact aquatic species. In addition, the removal of dams and reservoirs could alter the availability and quality of habitat, resulting in direct and indirect effects on aquatic species. Although the Partial Removal Alternative would leave some Lower Klamath Project structures in place (Table 4.3-1 through Table 4.3-6), the entirety of each dam would be removed to ensure a free-flowing Klamath River and year-round volitional fish passage under all river stages and flow conditions. Under the Partial Removal Alternative, hatchery operations would continue with reduced production for eight years following dam removal, as described for the Proposed Project (Section 2.7.6 *Hatchery Operations*). Although there would be some decrease in construction-related activities under the Partial Removal Alternative due to some Lower Klamath Project structures remaining in place, the degree of difference would not be sufficient to significantly reduce water quality impacts identified for the Proposed Project. Therefore, the potential impacts to aquatic resources, and the potential mitigation measures, would be the same as those described for the Proposed Project (Potential Impacts 3.3-1 through 3.3-24).

4.3.4 Phytoplankton and Periphyton

Although the Partial Removal Alternative would leave some Lower Klamath Project structures in place (Table 4.3-1 through Table 4.3-6), the entirety of each dam would be removed to ensure a free-flowing Klamath River under all river stages and flow conditions. The hydrologic processes, suspended sediment transport, and nutrient conditions affecting phytoplankton and periphyton growth will therefore be the same under the Proposed Project and the Partial Removal Alternative. As such, the potential impacts to phytoplankton and periphyton (Potential Impact 3.4-1 through 3.4-5) due to implementation of the Partial Removal Alternative would be the same as those described for the Proposed Project.

4.3.5 Terrestrial Resources

4.3.5.1 Vegetation Communities

Under the Partial Removal Alternative there would be less construction activity as compared to the Proposed Project, since some structures would remain in place (see Table 4.3-1 through Table 4.3-6); however, there would still be construction activities in areas where there are sensitive habitats under existing conditions (Section 3.5.2.1 *Vegetation Communities*). Consequently, short-term impacts on sensitive habitats would be similar to those described for the Proposed Project (Potential Impacts 3.5-1 and 3.5-2), including impacts on wetlands and riparian habitats along the Lower Klamath Project reservoirs, river reaches (i.e., Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam), and locations associated with bridges to be replaced or upgraded prior to reservoir drawdown. Implementation of Mitigation Measure TER-1 would reduce these potential short-term impacts to less than significant.

Additionally, under the Partial Removal Alternative, there may be short- and long-term impacts on wetland and riparian habitat due to reservoir drawdown and dam removal, similar to those of the Proposed Project (Potential Impacts 3.5-3 through 3.5-6). Proposed activities contained within the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*), in combination with natural recruitment of riparian habitat along newly-formed tributary reaches within the former reservoir footprint, may result in a net increase in the areal extent of riparian habitat within the terrestrial resources Area of Analysis (Potential Impact 3.5-5). Furthermore, as with the Proposed Project, loss of riparian habitat from sedimentation downstream of the dams would be short-term in nature. Overall, short-term and long-term impacts on wetland and riparian habitat from implementation of the Partial Removal Alternative would be less than significant.

4.3.5.2 Culturally Significant Species

Similar to the Proposed Project, many of the species identified by the Native American Tribes in the Klamath River region as culturally significant occur in riparian and wetland habitats. The goal of no net loss of wetland or riparian habitat acreage and functions would still apply under the Partial Removal Alternative, and the revegetation mixes would be developed based on updated inventories of existing wetland and riparian vegetation around the reservoir perimeters; therefore, culturally significant species would be documented and incorporated as part of the revegetation effort. In addition, Mitigation Measure TER-1 (see Potential Impact 3.5-1) includes wetland buffers to prevent intrusion in wetland habitats, deter heavy machinery from traversing the wetland, prevent runoff pollution from directly entering the wetland, and avoid substantial degradation in these areas. These measures would reduce short- and long-term impacts on culturally significant species to less than significant under this alternative.

4.3.5.3 Special-status Species

Under the Partial Removal Alternative there would be less construction activity as compared to the Proposed Project as some structures would remain in place (see Table 4.3-1 through Table 4.3-6); however, short-term construction-related noise would still be generated due to the removal of the large majority of the dam complexes, including the entirety of each dam, and sealing of remaining structures and installation of security fencing. Thus, retaining some structures under the Partial Removal Alternative would not reduce noise-related impacts on special-status bats or birds to a less than significant level. Although bats are known to use some of the structures that would be retained (i.e., Copco No. 1, Copco No. 2, and Iron Gate powerhouses, see Section 3.5.5.3 *Special-status Species and Rare Natural Communities*), the Partial Removal Alternative would seal openings in the structures that remain, which would prevent bats from accessing the inside of the structures.

The structures that currently support the largest of the known bat roosts (e.g., Copco No. 1 and Iron Gate diversion tunnels) would be removed under this alternative. Birds may be nesting on the exterior of the structures that would be retained and potentially affected by facility preservation. As such, short- and long-term construction-related potential impacts (Potential Impacts 3.5-9, 3.5-10, 3.5-11, 3.5-12, 3.5-13, 3.5-14, 3.5-15, and 3.5-28) on terrestrial resources would be the same as those described for the Proposed Project. The mitigation measures and recommended terrestrial measures also would be the same as those identified for the Proposed Project.

Similarly, even though there would be less construction activity under the Partial Removal Alternative as compared to the Proposed Project, special-status plants and rare natural communities may be present in the areas where construction activities may be performed. Consequently, short-term impacts on special-status plants and rare natural communities may would be similar to those of the Proposed Project (Potential Impacts 3.5-7 and 3.5-8). The same terrestrial resource measures would apply as under the Proposed Project, which would include surveys for special-status species and rare natural communities, implementation of avoidance measures and invasive species control (Appendix B: *Definite Plan – Appendix J*). There may be significant impacts on special-status plants where avoidance is infeasible and if replanting does not succeed in re-establishment of new populations; therefore, recommended measures would be the same as those identified for the Proposed Project.

Short-term impacts of high SSCs and flows, as they relate to special-status amphibian and reptile species (Potential Impacts 3.5-16 and 3.5-18), would also be the same under the Partial Removal Alternative as those described under the Proposed Project, since retaining some structures would not affect proposed reservoir drawdown rates or the degree of mobilization of Lower Klamath Project reservoir sediment deposits.

For the same reasons as described under the Proposed Project, there would be the potential short- and long-term impacts due to loss of aquatic reservoir, wetland, and riparian habitats (Potential Impact 3.5-8) under the Partial Removal Alternative. However, as discussed under the Proposed Project, implementation the Reservoir Area Management Plan (Appendix B: *Definite Plan – Appendix H*) in combination with natural recruitment along newly-formed tributary reaches within the former reservoir footprint may result in a net increase in the areal extent of riparian habitat within the terrestrial resources Area of Analysis (Potential Impact 3.5-5). The extent of both impacts and remediation would be functionally the same under both the Proposed Project and the Partial Removal Alternative. Therefore, short- and long-term potential impacts on special-status plants (Potential Impacts 3.5-9) and special-status wildlife (Potential Impacts 3.5-15, 3.5-17, 3.5-19–22, and 3.5-24) would be similar to those described for the Proposed Project and recommended measures would be the same.

Under this alternative, Iron Gate Hatchery would operate with reduced production goals, Fall Creek Hatchery would be reopened, and water would be diverted from Bogus Creek and Fall Creek as described under the Proposed Project; thus, potential construction-related impacts, impacts from loss of hatchery production on wildlife, and flow diversion impacts would be the same as those described under the Proposed Project (Potential Impacts 3.5-10 3.5-25, 3.5-26, and 3.5-27).

4.3.5.4 Wildlife Corridors and Habitat Connectivity

Retaining some structures (Table 4.3-1 through Table 4.3-6) under the Partial Removal Alternative would result in no change from existing conditions. Effects on wildlife corridors and habitat connectivity would be slightly less beneficial in terms of opening migration opportunities than those described for the Proposed Project because the steel penstocks would remain and may impede wildlife migration. The largest length of parallel penstocks that would remain at Copco No. 1 is approximately 230 feet and at Copco No. 2 is approximately 410 feet. Powerhouses and intake structures that would remain do not present a migration barrier under existing conditions. There would be long-term benefits to wildlife from gains in upland and riparian habitat following establishment of newly planted areas, which would include monitoring and control of invasive plants (see Reservoir Area Management Plan [Appendix B: *Definite Plan – Appendix H*]). Drawdown of the reservoirs and removing the dams would benefit some terrestrial species by eliminating migration barriers, as described above (Potential Impacts 3.5-23, 3.5-29, and 3.5-30).

4.3.6 Flood Hydrology

Although the Partial Removal Alternative would leave some Lower Klamath Project structures in place (see Table 4.3-1 through Table 4.3-6), the entirety of each dam would be removed to ensure a free-flowing Klamath River under all river stages and flow conditions. The retained Copco No. 1, Copco No. 2, and Iron Gate powerhouses would likely remain within the 100-year floodplain after dam removal, based on their position within the current FEMA designated 100-year floodplain (FEMA 2011a,b) and there would be no change from existing conditions with respect to flood risk for the remaining powerhouse structures. Overall, the potential flood hydrology impacts of the Partial Removal Alternative would be the same as those described for the Proposed Project and there would be no significant impacts for Potential Impacts 3.6-1, 3.6-2, and 3.6-4 through 3.6-6 (short term). For reasons described under the Proposed Project, the long-term effect of this alternative would be beneficial for Potential Impact 3.6-6. There would be significant and unavoidable impacts related to exposing structures to a substantial risk of damage due to flooding downstream of the location of Iron Gate Dam (Potential Impact 3.6-3).

4.3.7 Groundwater

The retention of some structures under the Partial Removal Alternative (e.g., powerhouse elements, penstocks, some buildings, see also Table 4.3-1 through Table 4.3-6) would not result in different impacts to groundwater resources compared with those described for the Proposed Project. Thus, the potential impacts of the Partial Removal Alternative on groundwater would be the same as those described for the

Proposed Project (Potential Impacts 3.7-1 and 3.7-2) and there would be no significant impacts.

4.3.8 Water Supply/Water Rights

The retention of some structures under the Partial Removal Alternative (e.g., powerhouse elements, penstocks, some buildings, see also Table 4.3-1 through Table 4.3-6) would not result in different impacts to water supply/water rights compared with those described for the Proposed Project. Thus, the potential impacts of the Partial Removal Alternative on water supply/water rights, and the potential mitigation measures, would be the same as those described for the Proposed Project. Potential Impacts 3.8-1, 3.8-2, and 3.8-5 would result in no significant impacts.

Under the Partial Removal Alternative, the same degree of mobilization of Lower Klamath Project reservoir sediment deposits would occur as under the Proposed Project, such that release of stored sediment during reservoir drawdown could still impact water intake pumps downstream from Iron Gate Dam (Potential Impact 3.8-3). As under the Proposed Project, implementation of Mitigation Measure WSWR-1 would reduce this potential impact to less than significant.

The City of Yreka's municipal water supply pipeline would still need to be relocated following drawdown of Iron Gate Reservoir (Potential Impact 3.8-4), and there would still be potential for disruption to the City's water supply. Implementation of Mitigation Measure WSWR-2 would reduce this potential impact to less than significant.

4.3.9 Air Quality

Although there would be a decrease in construction-related activities under the Partial Removal Alternative due to several of the Lower Klamath Project structures remaining in place (Table 4.3-1 through Table 4.3-6), the degree of difference would not be sufficient to significantly reduce the potential effects of dam removal on construction-related air quality impacts described for the Proposed Project (Potential Impacts 3.9-1 through 3.9-5). With respect to potential exceedances of the Siskiyou County Air Pollution Control District (SCAPCD) emissions thresholds in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants) (Potential Impact 3.9-2), estimated total daily emissions from the Partial Removal Alternative would still exceed the SCAPCD's significance thresholds for NOx, PM_{10}, and $PM_{2.5}$ (Table 4.3-7). While there would be less excavation and cut/fill activities than the Proposed Project due to the smaller construction footprint, emissions associated with the other project activities would be relatively unaffected because the peak number of truck trips, amount of construction equipment, and number of temporary workers does not substantially change between the Proposed Project and this alternative. As such, the construction emissions from the Partial Removal Alternative would be significant.

As with the Proposed Project, since the Yreka water pipeline relocation would occur prior to initiating drawdown of the Iron Gate Reservoir, the construction emissions from this activity do not have the potential to occur at the same time as the other activities and should be considered separately. As shown in Table 4.3-7, the emissions from the relocation of the Yreka water supply pipeline as an isolated activity would be below the significance criteria.

Table 4.3-7. Uncontrolled Daily Emissions for the Partial Removal Alternative.[1]

Project Activity	Peak Daily Emissions (pounds per day)[2]					
	VOC	CO	NO_x	SO_x	PM_{10}	$PM_{2.5}$
Dam and Powerhouse Deconstruction	128	570	625	9	484	244
Restoration Activities	19	62	168	20	3	3
Recreation Facilities	12	77	85	0	17	7
Yreka Water Supply Pipeline Relocation	3	16	18	0	10	3
Total Maximum Daily	162	725	**896**	29	**514**	**257**
Significance Criterion[2]	250	2,500	250	250	250	250

Source: Appendix N

Notes:

[1] Values shown in grey highlight exceed the Siskiyou County Air Pollution Control District's (SCAPCD) thresholds of significance in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants).

Key:

VOC = volatile organic compounds
CO = carbon monoxide
NO_x = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

As discussed for the Proposed Project (Potential Impact 3.9-2), the KRRC's current proposal lacks sufficient detail concerning construction activities and it is too speculative to determine whether the air quality mitigation measures proposed in the 2012 KHSA EIS/EIR are feasible and enforceable. As such, the analysis of the Partial Removal Alternative does not include mitigation to minimize impacts from construction emissions generated by the alternative's activities. Since similar minimization measures may be implemented during project construction, it is assumed that the emissions generated by the Partial Removal Alternative would fall somewhere in the range between the uncontrolled and mitigated emissions estimates contained in Appendix N. Due to this uncertainty, the emissions of NOx, PM_{10}, and $PM_{2.5}$ from the Partial Removal Alternative are found to be significant and unavoidable.

4.3.10 Greenhouse Gas Emissions

The Partial Removal Alternative would result in few direct operational greenhouse gas (GHG) emissions. As noted for the Proposed Project (see Potential Impact 3.10-1), direct GHG emissions associated with operation of the Iron Gate Hatchery and Fall Creek Hatchery are assumed to be the same as existing baseline GHG emissions associated with current hatchery operations. Appreciable direct GHG emissions would occur only for a limited time as a result of construction related to dam deconstruction, restoration, relocation and demolition of recreational facilities, Yreka supply pipeline relocation. Since uncontrolled direct total GHG emissions from construction-related and restoration activities under the Proposed Project would be approximately 9,455 MTCO2e (Table 3.10-2), which is below the SCAQMD's 10,000 MTCO2e significance threshold, any decrease in emissions due to less construction-related and restoration activity emissions under the Partial Removal Alternative, however small, would also result in a less than significant impact.

The removal of power production is the same under both the Proposed Project and the Partial Removal Alternative. The potential for indirect production of GHG emissions under the Partial Removal Alternative would be less than significant because this alternative would not affect PacifiCorp plans to add new sources of renewable power or purchase renewable energy credits (RECs) to comply with the California Renewable Portfolio Standard (RPS) (PacifiCorp 2017b), and removal of the reservoirs would still occur which would result in a reduction in methane production (Potential Impact 3.10-2).

4.3.11 Geology, Soils, and Mineral Resources

Under the Partial Removal Alternative, removal of the Lower Klamath Project embankment/earth-filled dam and concrete dam structures would still occur to ensure a free-flowing Klamath River under all river stages and flow conditions. Thus, compared with the Proposed Project, the same degree of mobilization of Lower Klamath Project reservoir sediment deposits would occur under the Partial Removal Alternative. The retention of some structures under the Partial Removal Alternative (e.g., powerhouse elements, penstocks, some buildings, see also Table 4.3-1 through Table 4.3-6) would not result in different impacts related to geology and soils compared with those described for the Proposed Project. Therefore, potential impacts under the Partial Removal Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.11-1, 3.11-2, 3.11-3, 3.11-4, 3.11-5, 3.11-6, 3.11-7). As with the Proposed Project, Mitigation Measure GEO-1 would be required to be implemented as part of the Partial Removal Alternative to reduce potential impacts due to short-term hillslope instabilities during reservoir drawdown (Potential Impact 3.11-3).

4.3.12 Historical and Tribal Cultural Resources

The potential impacts of the Partial Removal Alternative on Copco No. 1 Dam, Copco No. 2 Dam, and Iron Gate Dam, their associated hydroelectric facilities, and the Klamath River Hydroelectric Project District as a whole, would be less than those described for the Proposed Project (Potential Impact 3.12-11) because some of the Lower Klamath Project structures would be retained. The Partial Removal Alternative would retain (entirely or partially) the following structures of potential historical significance: Copco No. 1 powerhouse and penstocks; Copco No. 2 power penstock intake structure and gate, tunnel portals, steel penstock (including supports and anchors[189]), and powerhouse; and the lower portion of the Iron Gate Dam powerhouse (Table 4.3-1 through Table 4.3-6). Leaving these structures in place would reduce potential impacts to the proposed Klamath River Hydroelectric Project District relative to those described for the Proposed Project. However, impacts to the other structures of potential historical significance within the proposed Klamath River Hydroelectric Project District would still occur under this alternative. The Copco No. 1 Dam, gate houses [190], warehouse and residence (Table 4.3-1), the Copco No. 2 Dam, spillway gates and structure, remnant cofferdam, wooden-stave penstock, concrete pipe cradles, oil and gas storage building, and certain features of the Copco Village, which are considered to be features of potential historical significance (Table 4.3-3), and the Iron Gate embankment dam,

[189] Supports and anchors not specified as part of the National Register Eligibility Recommendation.

[190] While it would be possible to partially remove the gate houses, they are likely to be fully removed to facilitate construction access (e.g., to allow a large crane to access the site). For the purposes of this CEQA analysis, it is assumed that the gate houses would be removed.

penstock intake structure, penstock, spillway structure, fish facilities on the dam, and certain features of the additional ancillary facilities (Table 4.3-5), would still be removed under the Partial Removal Alternative. Removal of these features, or any others within the Klamath Hydroelectric Historic District that are determined to have potential historical significance through the FERC process, would result in the physical destruction of the resource or its immediate surroundings in a way that would materially impair the significance of the historical resource. Thus, while the impact to historical resources would be reduced as compared to the Proposed Project, the Partial Removal Alternative would still result in a significant impact on the historical built environment (Potential Impact 3.12-11). Further, for reasons described under the Proposed Project, the impact to the Klamath Hydroelectric Historical District would be significant and unavoidable even with inclusion of the KRRC's proposed mitigation measure (i.e., implementation of a final Historic Properties Management Plan and Programmatic Agreement).

The retention of the aforementioned structures under the Partial Removal Alternative would not result in different effects related to either historic-period archaeological resources or tribal cultural resources compared with those described for the Proposed Project. Therefore, potential impacts and beneficial effects on these resources and any associated mitigation measures under the Partial Removal Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.12-1 through 3.12-10 and 3.12-12 through 3.12-16).

4.3.13 Paleontologic Resources

The retention of some structures under the Partial Removal Alternative (e.g., powerhouse elements, penstocks, some buildings, see also Table 4.3-1 through Table 4.3-6) would not result in different impacts to paleontologic resources compared with those described for the Proposed Project. There would be no significant impact of the Partial Removal Alternative on paleontologic resources (Potential Impact 3.13-1).

4.3.14 Land Use and Planning

The retention of some structures under the Partial Removal Alternative (e.g., powerhouse elements, penstocks, some buildings, see also Table 4.3-1 through Table 4.3-6) would not result in different potential impacts to land use and planning resources compared with those described for the Proposed Project. Thus, under the Partial Removal Alternative, potential impacts on land use and planning would be the same as those described for the Proposed Project (Potential Impacts 3.14-1 and 3.14-2) and there would be no significant impacts.

4.3.15 Agriculture and Forestry Resources

The retention of some structures under the Partial Removal Alternative (e.g., powerhouse elements, penstocks, some buildings, see also Table 4.3-1 through Table 4.3-6) would not result in different impacts to agriculture and forestry resources compared with those described for the Proposed Project. Thus, under the Partial Removal Alternative, potential impacts on agriculture and forestry resources would be the same as those described for the Proposed Project and there would be no significant impacts (Potential Impacts 3.15-1 through 3.15-3).

4.3.16 Population and Housing

Although there would be a decrease in construction-related activities under the Partial Removal Alternative due to several of the Lower Klamath Project structures remaining in place (Table 4.3-1 through Table 4.3-6), the number of temporary workers would not substantially change between the Proposed Project and this alternative since workers would still be needed for sealing and security fence installation around the structures that remain. Additionally, this alternative would adhere to the same schedule as the Proposed Project (Table 2.7-1) since it would require time to secure retained facilities by removing hazardous materials and installing fences (Section 4.3.1 *[Partial Removal Alternative] Introduction – Alternative Analysis Approach*). Thus, potential impacts to population and housing under the Partial Removal Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.16-1 and 3.16-2) and this alternative would not induce substantial population growth or displace substantial numbers of people or existing housing. Implementation of the Partial Removal Alternative would have no significant impacts on population and housing.

4.3.17 Public Services

Although there would be a decrease in construction-related activities under the Partial Removal Alternative due to several of the Lower Klamath Project structures remaining in place (see Table 4.3-1 through Table 4.3-6), the degree of difference would not be enough to significantly change the assessment of dam removal effects on public services compared with those described for the Proposed Project (Potential Impacts 3.17-1 through 3.17-3). This alternative would still result in significant impacts due to short-term increased response times for emergency fire, police, and medical services, increased risk of wildfires and the need for firefighting measures, increased need of police protection, and personal and public health and safety risks and need for medical services (Potential Impact 3.17-1). Implementation of Mitigation Measure HZ-1 (Section 3.21 *Hazards and Hazardous Materials*) would reduce impacts for reasons described under the Proposed Project. However, the KRRC is developing a Traffic Management Plan to identify mitigation and other protective measures that would be implemented to reduce impacts to public services. Overseeing development and implementation of a Traffic Management Plan does not fall within the scope of the State Water Board's water quality certification authority. While the State Water Board expects that the Traffic Management Plan will be finalized and implemented, at this time the plan is not finalized, and the State Water Board cannot require its implementation. Accordingly, while the State Water Board anticipates that implementation of HZ-1 and Recommended Measure TR-1 would reduce impacts to public services, because it cannot require implementation of Recommended Measure TR-1, it is analyzing the impacts under this alternative as significant and unavoidable.

Under the Partial Removal Alternative, elimination of the Lower Klamath Project reservoirs as a long-term water source for wildfire services and the associated increase in response times for fighting wildfires (Potential Impact 3.17-2) would result in the same impacts as described for the Proposed Project because removal of the Lower Klamath Project reservoirs would still occur to ensure a free-flowing Klamath River under all river stages and flow conditions. The KRRC is working on an updated Fire Management Plan to identify mitigation and other protective measures that would be implemented to reduce impacts to wildfire services. Overseeing development and implementation of the Fire Management Plan does not fall within the scope of the State Water Board's water quality certification authority. While the State Water Board expects that it will be finalized and implemented, at this time the plan is not finalized, and the State Water Board cannot require its implementation. Accordingly, while the State Water Board anticipates that implementation of the Fire Management Plan and its incorporation of Recommended Measure PS-1 would reduce impacts to wildfire services, because it cannot require implementation, it is analyzing the impacts under this alternative as significant and unavoidable.

Potential impacts on school services and facilities (Potential Impact 3.17-3) under this alternative would be the same as described for the Proposed Project and would be less than significant.

4.3.18 Utilities and Service Systems

Although there would be a decrease in construction-related activities under the Partial Removal Alternative due to several of the Lower Klamath Project structures remaining in place (Table 4.3-1 through Table 4.3-6), the degree of difference would not be sufficient to significantly change the assessment of dam removal activities on the need for wastewater treatment (Potential Impact 3.18-1) or the need for stormwater drainage facilities (Potential Impact 3.18-2) under the Proposed Project, and there would be no significant impacts to these service systems.

Under the Partial Removal Alternative, there would be a reduction in waste disposal as compared to the Proposed Project since numerous features listed in Table 4.3-2, Table 4.3-4, and Table 4.3-6 would not be demolished and would instead be either disposed of onsite or offsite, depending on the material (see also Potential Impacts 3.18-3 and 3.18-4). For example, the Copco No. 1 and 2 powerhouse cranes (multiple 40-ton travelling indoor cranes and 15-ton overhead cranes), and 1,400 feet of steel penstocks would remain under the Partial Removal Alternative, but would be demolished under the Proposed Project. Likewise, the concrete from the bottom portion of the Iron Gate Powerhouse would remain under the Partial Removal Alternative, but would be demolished under the Proposed Project. Since the anticipated volume of waste generation for the Proposed Project is less than the identified capacities for local landfill facilities (described in Section 3.18.2.4 *Solid Waste*), and the Partial Removal Alternative would result in less construction-related waste, there would be sufficient capacity to accommodate the solid waste disposal needs of the Partial Removal Alternative, and potential waste disposal impacts would be less than significant.

4.3.19 Aesthetics

Although the Partial Removal Alternative would leave some Lower Klamath Project structures in place (see Table 4.3-1 through Table 4.3-6), the entirety of each dam would be removed to ensure a free-flowing Klamath River under all river stages and flow conditions. Thus, under the Partial Removal Alternative, the long-term change from open water lake vistas to river, canyon, and valley vistas would still occur and would not result in a significant impact (Potential Impact 3.19-1). In the short term, there would still be significant and unavoidable aesthetic impacts due to barren areas within the reservoir footprints, which would be created during reservoir drawdown and would remain until vegetation in previously inundated areas establishes (Potential Impact 3.19-4). As described for the Proposed Project, there would be no significant impacts to scenic resources resulting from changes in flows and channel morphology (Potential Impact

3.19-2) or increased turbidity and reduced clarity during reservoir drawdown (Potential Impact 3.19-3). Long-term changes in visual water quality (reduced algal blooms) would be beneficial (Potential Impact 3.19-3) under the Partial Removal Alternative for the reasons described under the Proposed Project.

The retention of some structures under the Partial Removal Alternative (e.g., powerhouse elements, penstocks, some buildings, see Table 4.3-1 through Table 4.3-6) would mean that the visual character of the Lower Klamath Project area would continue to be affected by the remaining man-made features. However, as the remaining features are already part of the existing conditions (i.e., environmental baseline), the aesthetic effect of removing the other large existing structures (e.g., dams, some buildings) the would be beneficial as compared with existing conditions, even though the benefits would be of a slightly lesser degree than those described for the Proposed Project (Potential Impact 3.19-5). Visual impacts due to construction of new infrastructure and improvements to existing infrastructure would be less than significant for the reasons described for the Proposed Project (Potential Impact 3.19-5). In general, short-term construction-related impacts to visual resources under the Partial Removal Alternative would be slightly less than those described for the Proposed Project and as such would be less than significant (Potential Impact 3.19-6). The exception to this is short-term lighting impacts; because construction would still occur at night over a period of several months, the potential impact due to construction lighting would also be significant for this alternative (Potential Impact 3.19-7). The Proposed Project currently does not include measures that would reduce impacts to nighttime views cause by temporary construction lighting. KRRC proposes that KRRC and the appropriate state or local agency would work together to develop recommended terms and conditions that should be adopted by FERC as conditions of approval for the Lower Klamath Project. This is consistent with FERC's preference for licensees to be 'good citizens' of the communities in which projects are located and thus to comply, where possible, with state and local requirements. It would be appropriate for any such terms to include measures to reduce nighttime light and glare on surrounding residences during construction. However, overseeing development and implementation of measures to reduce impacts to nighttime views does not fall within the scope of the State Water Board's water quality certification authority. While the KRRC has stated its intention to reach enforceable good citizen agreements that will be finalized and implemented, at this time these agreements are not finalized and the State Water Board cannot require their implementation. Accordingly, while the State Water Board anticipates that implementation of the final FERC terms and conditions for the Proposed Project would reduce potential impacts to nighttime views to less than significant, because the State Water Board cannot ensure implementation of any associated measures, it is analyzing the impact in this Draft EIR as significant and unavoidable.

4.3.20 Recreation

Since none of the structures that would be retained under the Partial Removal Alternative are related to recreation (see Table 4.3-1 through Table 4.3-6), and since the reservoirs themselves would not be retained, the potential impacts of the Partial Removal Alternative on recreational opportunities would be the same as those described for the Proposed Project and there would be no significant impacts in the short term (Potential Impacts 3.20-1, 3.20-2, 3.20-3, and 3.20-4). For reasons described under the Proposed Project, while there would be no short-term and long-term significant impacts to whitewater boating recreational activities in most Klamath River reaches, there would be significant and unavoidable changes to Hell's Corner area in the upper Hydroelectric Reach in the short and long term (Potential Impact 3.20-5). In the short term, there would be no significant impact on non-boating river-based recreation (e.g., fishing) and in the long term there would be a beneficial effect (Potential Impact 3.20-6). Similarly, there would also be beneficial effects on the designated California Klamath River wild and scenic river segment, and eligible and suitable California Klamath River wild and scenic river section (Potential Impact 3.20-7).

4.3.21 Hazards and Hazardous Materials

Although there would be a decrease in construction-related activities under the Partial Removal Alternative due to several of the Lower Klamath Project structures remaining in place (see Table 4.3-1 through Table 4.3-6), the degree of difference would not be enough to change the potential for hazard-related impacts due to transport or use of hazardous materials during construction activities, as compared with those described under the Proposed Project. Some of the features proposed to be retained under the Partial Removal Alternative may have coatings that contain heavy metals (such as the penstocks) and that would be exposed during or following construction activities. These features would require preservation under the Partial Removal to reduce the risk of environmental contamination. Overall, the hazards and hazardous materials-related potential impacts and mitigation would be the same as those described for the Proposed Project (Potential Impacts 3.21-1 through 3.21-7).

4.3.22 Transportation and Traffic

Although there would be a decrease in construction-related activities under the Partial Removal Alternative due to several of the Lower Klamath Project structures remaining in place (Table 4.3-1 through Table 4.3-6), the degree of difference would not be enough to significantly reduce the potential effects of dam removal on construction-related traffic described for the Proposed Project (Potential Impacts 3.22-1 through 3.22-5). This is because while there would be less excavation and cut/fill activities than anticipated for the Proposed Project (due to the smaller construction footprint), the peak number of truck trips, construction equipment, or temporary workers would not substantially change between the Proposed Project and this alternative to allow for sealing of and fencing installation around structures that remain. Overall, transportation and traffic potential impacts would be the same as those described for the Proposed Project (Potential Impacts 3.22-1 through 3.22-5) and would be significant. The KRRC is working on developing a Traffic Management Plan and an Emergency Response Plan to identify mitigation and other protective measures that would be implemented to reduce potential impacts to transportation and traffic. Overseeing development and implementation of the Traffic Management Plan and the Emergency Response Plan does not fall within the scope of the State Water Board's water quality certification authority. While the State Water Board expects that these plans will be finalized and implemented, at this time the plans are not finalized, and the State Water Board cannot require their implementation. Accordingly, while the State Water Board anticipates that implementation of the Traffic Management Plan and the Emergency Response Plan would reduce impacts to transportation and traffic, because it cannot require implementation, it is analyzing the impacts as significant and unavoidable.

For reasons described under the Proposed Project (Potential Impact 3.22-6), this alternative would not require a change in air traffic that would result in substantial safety risks, and there would be no significant impact.

4.3.23 Noise

Although there would be a decrease in construction-related activities under the Partial Removal Alternative due to several of the Lower Klamath Project structures remaining in place (Table 4.3-1 through Table 4.3-6), the degree of difference would not be sufficient to significantly reduce the potential effects of dam removal related to noise and vibration. Short-term construction related noise impacts due to any use of dozers, jackhammers, and/or tractors during the Partial Removal Alternative would constitute an exceedance of Siskiyou County maximum allowable noise levels and this would be a significant impact (Potential Impact 3.23-1). Deconstruction of Copco No. 1 Dam (Potential Impact 3.23-2), deconstruction of Iron Gate Dam (Potential Impact 3.23-4), restoration activities at Copco No. 1 and Iron Gate reservoirs (Potential Impact 3.23-5), and blasting at Copco No. 1 Dam (Potential Impact 3.23-6) would remain significant and unavoidable under the Partial Removal Alternative.

The analysis of the Partial Removal Alternative assumes that deconstruction techniques for this alternative are the same as for the Proposed Project, with no specialized means or methods necessary. The analysis also assumes that the Partial Removal Alternative would use the same equipment as the Proposed Project. Thus, as described for the Proposed Project, there would be no significant impacts from the Partial Removal Alternative due to construction activities associated with deconstruction of Copco No. 2 Dam (Potential Impact 3.23-3), the Downstream Flood Control project component (moving or elevating legally established structures located within the altered 100-year floodplain, where feasible) (Potential Impact 3.23-8), Mitigation Measure WSWR-1 (modify water intakes) (Potential Impact 3.23-9), and construction activities associated with the deepening or replacement of existing groundwater wells adjacent to the reservoirs (Potential Impact 3.23-10).

Under the Partial Removal Alternative, waste disposal would be somewhat reduced as compared to the Proposed Project since numerous features listed in Table 4.3-2, Table 4.3-4, and Table 4.3-6 would not be demolished, and would either disposed of on-site or off-site, depending on the material (Compare with Potential Impacts 3.18-3 and 3.18-4). As the Partial Removal Alternative would result in less construction-related waste than the Proposed Project (see Potential Impact 3.18-7), the need to transport waste to off-site landfills and construction worker commutes would likely be reduced under the Partial Removal Alternative. Transporting waste off-site and construction worker commutes would result in less than significant noise impacts for receptors 50 feet or more from all local roadways under the Proposed Project. Since there would be a reduction of this impact under the Partial Removal Alternative as compared to the Proposed Project, there would be a less than significant impact.

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4.4 Continued Operations with Fish Passage Alternative

4.4.1 Introduction

4.4.1.1 Alternative Description

In the Continued Operations with Fish Passage Alternative, the J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dam complexes would be relicensed by FERC for continued operations with changes to allow for upstream and downstream fish passage and updated flow requirements. More specifically, the Continued Operations with Fish Passage Alternative assumes mandatory conditions issued by the USFWS, NMFS, and BLM, and FERC staff for the relicensing of PacifiCorp's Klamath Hydroelectric Project described in the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative*[191]. The primary conditions under the Continued Operations with Fish Passage Alternative are:

- *Fishways Prescriptions* – volitional year-round upstream and downstream fish passage at J.C. Boyle, Copco No.1, Copco No. 2, and Iron Gate dams consistent with the prescriptions from the DOI and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007) and upheld in a trial-type administrative hearing, and specific fishway facility design and construction details included in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*[191], including fishway (i.e., fish ladder and screens) installation for both upstream and downstream migrations at all four Lower Klamath Project dam complexes and barriers to prevent juvenile salmonid entrainment into turbines;
- *Changes to J.C. Boyle Operations* – at least 40 percent of J.C. Boyle Reservoir inflow to be released downstream through the J.C. Boyle Bypass to increase minimum flows in the Bypass Reach. The generation of peaking power at J.C. Boyle Power Plant would be limited to one day per week, as water supplies allow, with the weekly peaking power flows also being used for recreation (whitewater boating) flows. Power generation would be suspended and all inflow to J.C. Boyle Reservoir would be released down the Bypass Reach under a seasonal high flow event that would occur for seven full days in later winter/spring when inflows to J.C. Boyle first exceed 3,300 cfs (DOI 2007, NMFS 2007, FERC 2007); and
- *Changes to Copco No. 2 Operations* – increase in minimum flows for the Copco No. 2 Bypass Reach, with a release of 70 cfs or inflow, whichever is less, to the bypass reach. Inflow would be computed as a 3-day running average of flows at the J.C. Boyle Powerhouse gage added to the flow from Shovel Creek, as measured by a new gage (FERC 2007).

The following conditions under the Continued Operations with Fish Passage Alternative are modifications to the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative*:

- Flows specified in the NMFS and USFWS 2013 BiOp for the USBR Klamath Irrigation Project, which are currently being considered under reinitiated consultation (see also 3.1.6.1 *Klamath River Flows under the Klamath Irrigation Project's 2013 BiOp*);

[191] The KHSA 2012 EIS/EIR's *Section 2.4.5 Fish Passage at Four Dams Alternative* (included in Appendix U of this EIR) include fishway facility design and construction details beyond what are specifically required in the FERC prescriptions and that are based on designs of similar fishway facilities used at other hydroelectric facilities. The 2012 alternative is essentially the *Staff Alternative with Mandatory Conditions* in the 2007 FERC EIS (see 2007 FERC EIS Section 2.3.3).

- Court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam, which became required after February 2017 (U.S. District Court 2017) (see also Section 4.2.1.3 *Summary of Available Hydrology Information for the No Project Alternative*); and
- Design and implementation of a Reservoir Management Plan, as described in the 2014 water quality certification application for Klamath Hydroelectric Project operations.

This alternative does not make any assumptions about potential Oregon or California water quality certification conditions.

Additionally, this section includes a short discussion of differences in the potential impact of using fishways described in the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative* compared to passage using trap and haul. For such additional analysis, this EIR generally assumes that trap and haul would be as described by FERC (2007) and would consist of trapping adult upstream migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir and released downstream of Iron Gate Dam. This alternative assumes that trap and haul, like fishways prescriptions, would cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007).

The aforementioned flow-related measures would reduce overall power generation at the Lower Klamath Project dam development. This alternative assumes that installation of fish passage facilities would follow the schedule prescribed in the FERC relicensing process, which would allow downstream facilities to be installed prior to upstream passage facilities. Although the duration of construction for any individual facility would range from approximately four months to one year (Table 4.4-1), the entire process of installing fish passage at each of the four Lower Klamath Project dams would take place over a four- to eight-year period (FERC 2007). The level of construction would be consistent with that estimated for development of the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative*. Fish ladder construction would include building upstream fish ladders, spillway modifications, tailrace barriers, screens, and bypass structures (see Appendix U of this EIR for more details) and would require work in wet conditions (i.e., in-water) in areas that cannot be dewatered or dried. Construction would include the use of heavy equipment, and blasting as necessary (e.g., removal of the existing J.C. Boyle fish ladder structure). Workforce estimates for the Continued Operations with Fish Passage Alternative are provided in Table 4.4-1 and are generally less than workforce estimates for the Proposed Project (Table 2.7-8).

Table 4.4-1. Workforce Projections for Continued Operations with Fish Passage Alternative.

Dam	Estimated Average Construction Workforce	Construction Duration
J.C. Boyle*	10 to 20 people	4 to 6 months
Copco No. 1	15 to 25 people	9 months
Copco No. 2	10 to 20 people	4 to 6 months
Iron Gate	15 to 30 people	12 months

* J.C. Boyle Dam is included in this analysis as some of the traffic flow may use roads in California (e.g., I-5 to OR 66)
Source: 2012 KHSA EIS/EIR (USBR and CDFW 2012)

If instead of fish ladders, trap and haul were used, there would be the potential for reduced construction compared to the aforementioned activities for fish ladders. While trap and haul facilities differ by site, common features include a trap holding pool, diffusers or gates to guide fish into the trap, a channel or port for discharge of attraction flows, a lift mechanism for truck-loading fish, a truck loading station, and a discharge platform. Much of the trap and haul facility would be located in-stream, with only the truck loading station and discharge platform potentially requiring upland grading or other earthwork. Although trap and haul construction activities would be limited to the same construction period described above for fish ladders, hauling operations (i.e., truck trips to move fish) would be ongoing.

Under Continued Operations with Fish Passage, no KHSA Interim Measures (IMs) would continue, although actions consistent with IMs designed for water quality improvements are analyzed in this alternative as part of the Reservoir Management Plan (Section 4.4.2 *Water Quality*). Additionally, the “California Klamath Restoration Fund/Coho Enhancement Fund” restoration actions, described under the No Project Alternative (see also Table 4.2-1), would continue.

Under this alternative, Iron Gate Hatchery would continue to target current annual production goals as described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project – Fish Hatcheries*.

4.4.1.2 Alternative Analysis Approach

As for the Proposed Project, the potential impacts of the Continued Operations with Fish Passage Alternative are analyzed in comparison to existing conditions. Unless otherwise indicated, the significance criteria, area of analysis, environmental setting, and impact analysis approach, including consideration of existing local policies, for all environmental resource areas under the Continued Operations with Fish Passage Alternative are the same as those described for the Proposed Project (see Section 3.1 *Introduction* and individual resource area subsections in Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures*). The potential impacts for each environmental resource area are analyzed both in the short term and the long term, and unless otherwise indicated, use the same definitions of short term and long term as described for each resource area analyzed for the Proposed Project.

4.4.2 Water Quality

4.4.2.1 Water Temperature

In general, existing ongoing alterations to water temperatures caused by the reservoirs and by Lower Klamath Project operations (as described in Section 3.2.2.2 *Water Temperature*) would continue to occur under the Continued Operations with Fish Passage Alternative. Short-term and long-term potential impacts to water temperature due to implementation of the 2017 court-ordered flushing and emergency dilution flows under this alternative would be similar to the potential short-term impacts to water temperature described for the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-1). Flushing and emergency dilution releases could temporarily accentuate existing fall or spring shifts in water temperature that occur in the Middle Klamath River downstream of Iron Gate Dam, but this would be a less than significant impact on water temperatures since it would only promote the existing seasonal water temperature shift for the brief time period corresponding to the flow releases.

However, there are three actions under the Continued Operations with Fish Passage Alternative that would potentially modify water temperatures in the Klamath River and the Lower Klamath Project reservoirs relative to existing conditions in both the short term and long term: 1) increased minimum flows in the J.C. Boyle Bypass Reach and limited peaking operations at J.C. Boyle Powerhouse; 2) increased minimum flows for the Copco No. 2 Bypass Reach; 3) and implementation of a Reservoir Management Plan. These actions would alter water temperature relative to existing conditions in both the short term (0–5 years) and long term (5+ years). Changes to water temperature in the Klamath River and reservoirs from these three actions would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions and they are discussed below in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1.

The 2007 FERC EIS found that PacifiCorp's proposal for relicensing of the Klamath Hydroelectric Project failed to address the project's water quality impairments within and downstream of the Hydroelectric Reach (FERC 2007). The Klamath River TMDLs later assigned water temperature and dissolved oxygen dual (i.e., co-occurring) load allocations to Copco No. 1 and Iron Gate reservoirs for the stratification period (May through October) to ensure compliance with the dissolved oxygen and water temperature targets (i.e., dissolved oxygen consistent with 85 percent saturation or better through September, and 90 percent or better in October [see also Table 3.2-5], and natural water temperatures, where natural baseline summer mean water temperature is approximately 18.7ºC) within the reservoirs and to ensure support of cold freshwater habitat (COLD), which is a designated beneficial use. The Klamath River TMDLs created a physical "compliance lens" where both dissolved oxygen and temperature conditions meet Basin Plan objectives in a layer of water stretching from the point of entry to the reservoirs throughout the reservoir (the depth of the compliance lens within the reservoir is not fixed) (North Coast Regional Board 2010). Since 2007, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including water temperature. Study results, including those under IM 11 (see Table 4.2-1), have indicated that while proposed reservoir management techniques can improve some of the project impacts to water quality (e.g., transport of nuisance and/or noxious blue-green algae downstream of Iron Gate Dam [Austin et al. 2016, PacifiCorp 2018]), the various techniques have not resulted in water quality improvements at Copco No. 1 or Iron Gate reservoirs that create the TMDL compliance lens nor have they otherwise sufficiently improved Klamath Hydroelectric Project impacts to water temperature (PacifiCorp 2017, 2018). Results from testing of a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11 indicate that modest water temperature improvement is possible using this technique; Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1 below discusses these results.

As described under the Proposed Project (Potential Impact 3.2-1), in the long-term (5+ years), climate change models for the Klamath Basin suggest that as the western United States warms, air temperatures will increase, there will be a slight increase in overall precipitation, winter snowfall will likely shift to higher elevations, and snowpack will be diminished as more precipitation falls as rain (Oregon Climate Change Research Institute [OCCRI] 2010). Bartholow (2005) predicted that in the Klamath Basin as a whole, increasing air temperatures and decreasing flows in the summer months would be expected to cause general increases in summer and fall water temperatures on the order of 2–3°C (3.6–5.4°F). Long-term water temperature trends relevant to consideration of effects of the Continued Operations with Fish Passage Alternative are also discussed below.

For the Continued Operations with Fish Passage Alternative, there would be no sediment release due to removal of the Lower Klamath Project. Thus, there would be no sediment-related morphological changes in the Klamath River Estuary due to dam removal that would be likely to increase estuary water temperatures in a manner that would cause or substantially exacerbate an exceedance of water quality standards or would result in a failure to maintain existing beneficial uses currently supported (Potential Impact 3.2-2) and there would be no significant impact.

Potential Impact 4.2.2-1 Seasonal alterations in water temperature due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

Under the Continued Operations with Fish Passage Alternative, J.C. Boyle Reservoir would remain in place but increased minimum flows in the J.C. Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse would decrease the large daily water temperature range that occurs under existing conditions when warmer reservoir water is diverted around the Bypass Reach to produce power (Section 3.2.2.2 *Water Temperature*). Areas adjacent to the cold water springs in the Bypass Reach would continue to serve as thermal refugia for aquatic species because the springs themselves would not be affected by the Continued Operations with Fish Passage Alternative.

The primary decrease in daily and seasonal flow fluctuations relative to existing conditions would occur in the J.C. Boyle Bypass Reach in Oregon because flow fluctuations in the downstream J.C. Boyle Peaking Reach in California (i.e., from the Oregon-California state line to Copco No. 1 Reservoir) are attenuated with distance downstream due to tributary inputs and accretion flows. With the limitation of peaking operations under this alternative, the temperature effects downstream from J.C. Boyle are similar to those described by removal of the facility, as described in Proposed Project (Potential Impact 3.2-1 *Hydroelectric Reach*). Maximum water temperatures at the Oregon-California state line would be slightly lower and temperatures would be less artificially variable relative to existing conditions due to higher overall flows and lower frequency of peaking operations at the J.C. Boyle Powerhouse (i.e., weekly peaking under this alternative as compared to daily peaking under existing conditions). The decrease in maximum daily water temperatures and temperature variability would be less than described under the Proposed Project, because there would still be peaking operations occurring one day per week in conjunction with recreational flows (see Section 4.4.1 *[Continued Operations with Fish Passage Alternative] Introduction*). Relative to existing conditions, the slight decreases in long-term maximum summer/fall water temperatures and less artificial diel temperature variation in the J.C. Boyle Peaking Reach would return the river to a more natural thermal regime, although the degree of benefit would be slightly lower than under the Proposed Project (Potential Impact 3.2-1). Elimination of the artificial temperature signal under existing conditions would better conform with the California Thermal Plan's prohibition on elevated temperature discharges (Table 3.2-4) and would be beneficial.

In the remainder of the Hydroelectric Reach (i.e., Copco No. 1 and Iron Gate reservoirs) water temperatures would be the same as those described under the existing condition (see Section 3.2.2.2 *Water Temperature*), where spring, summer, and fall water temperatures would continue to be influenced by the thermal mass of Copco No. 1 and Iron Gate reservoirs, and the seasonal stratification patterns of the two reservoirs. It is unclear what, if any, steps could reduce the impact of the reservoirs on the thermal regime within the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam and comply with the Thermal Plan's ban on elevated temperature discharges into COLD interstate waters (Table 3.2-4). Of the seven water quality improvement actions described in the Reservoir Management Plan[192], selective withdrawal and intake control is most focused on water temperature improvements. With respect to this approach, PacifiCorp has estimated that the maximum useable cool water volume in Copco No. 1 Reservoir in summer (approximately 3,100 acre-feet at less than 14°C and 4,800 acre-feet at less than 16°C) (PacifiCorp 2014b), which if selectively withdrawn from the reservoirs, would decrease water temperatures immediately downstream of Copco No. 1 Reservoir. It is currently unclear whether selective withdrawal from Copco No. 1 Reservoir alone would be sufficient to allow compliance with the Thermal Plan or to meet the Klamath TMDLs temperature requirement in the Hydroelectric Reach (see also below discussion in *Middle and Lower Klamath River and Klamath River Estuary*).

The increase in minimum flows in the Copco No. 2 Bypass Reach under this alternative would be expected to result in decreases in maximum summer/fall water temperatures and less artificial diel temperature variation than under existing conditions, returning the river to a more natural thermal regime, although the degree of benefit would be slightly lower than under the Proposed Project (Potential Impact 3.2-1). As for the J.C. Boyle Peaking Reach, elimination of any artificial temperature signal in the Copco No. 2 Bypass Reach under existing conditions would better conform with the California

[192] Water quality management techniques in the Reservoir Management Plan (PacifiCorp 2014b) for application in Copco No. 1 and Iron Gate reservoirs include the following techniques to control nutrients, algae, dissolved oxygen and pH: (1) constructed wetlands conceptual design and implementation planning; (2) further evaluation of tailrace aeration and oxygenation systems; (3) design and implementation planning of in-reservoir oxygenation systems; (4) evaluation of epilimnion (surface water) mixing and circulation; (5) further evaluation of selective withdrawal and intake control; (6) modeling and testing of deeper seasonal drawdown and fluctuation of the reservoirs; and (7) additional testing and controlled applications of SCP algaecide to treat localized areas (e.g., coves, embayments) in the reservoirs.

Thermal Plan's prohibition on elevated temperature discharges (Table 3.2-4) and would be beneficial.

As described under the Proposed Project (Potential Impact 3.2-1), for part of the Klamath Dam Removal Secretarial Determination studies, the effects of climate change were included in model projections for long-term water temperatures, including model runs assuming that the Lower Klamath Project dams remain in place. RBM10 model results using climate change predictions from five global circulation models (GCMs) (see also Section 3.2.4.1 *Water Temperature* and Appendix D) indicate that future water temperatures would be 1–2.3°C (1.8–4.1°F) warmer than historical temperatures in the Klamath Basin (Perry et al. 2011). While this temperature range is slightly lower than that estimated by Bartholow (2005), within the general uncertainty of climate change projections, the two modeling efforts correspond reasonably well and indicate that water temperatures in the Hydroelectric Reach are expected to increase within a 50-year period on the order of 1–3°C (1.8–5.4°F). RBM10 model results also show that with dams remaining in place, the thermal lag associated with the Lower Klamath Project reservoirs would continue to result in decreased river temperatures in the spring and increased river temperatures in the late summer/fall in the Hydroelectric Reach (Perry et al. 2011; USBR 2016), consistent with the general trend under existing conditions (3.2.2.2 *Water Temperature*).

The anticipated increases in water temperatures due to climate change would occur over a timescale of decades and would act in opposition to improvements expected from actions taken in furtherance of TMDL implementation throughout the Upper Klamath Basin, such as increased riparian shading and decreased diversion from cold springs (ODEQ 2010). While full implementation of the Klamath TMDLs is anticipated to result in late summer/fall reductions in water temperature in the range of 2–10°C immediately downstream from Iron Gate Dam (North Coast Regional Board 2010), there is currently no reasonable proposal to achieve the temperature allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place, despite the modest improvements exhibited through implementation of the Reservoir Management Plan during the past several years (PacifiCorp 2017, 2018). Thus, this EIR assumes that reasonably foreseeable late summer/fall water temperature improvements under the Continued Operations with Fish Passage Alternative would be on the lower end of the 2–10°C range, such that any improvements in late summer/fall water temperatures due to partial TMDL implementation would be completely offset by climate change increases of 1–3°C, and overall, under the Continued Operations with Fish Passage Alternative, late summer/fall water temperature conditions would not move towards a condition that supports designated beneficial uses, including cold freshwater habitat (COLD), rare, threatened, or endangered species (RARE), and migration of aquatic organisms (MIGR) annually during late summer/early fall (North Coast Regional Board 2010).

In summary, continued impoundment of water in Copco No. 1 and Iron Gate reservoirs under the Continued Operations with Fish Passage Alternative would maintain existing adverse late summer/fall water temperatures in the Hydroelectric Reach downstream of Copco No. 1 Reservoir (Section 3.2.2.2 *Water Temperature*). There is currently no reasonable proposal to achieve the temperature allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place, despite the modest improvements achieved to date through implementation of the Reservoir Management Plan. Further, long-term climate change-induced increases in water temperatures would partially offset any TMDL improvements. Overall, the Continued Operations with Fish Passage

Alternative would result in no change from existing adverse conditions in the Hydroelectric Reach and would continue to cause an exceedance of water quality standards as set forth in the Thermal Plan.

Middle and Lower Klamath River and Klamath River Estuary

The Continued Operations with Fish Passage Alternative would have similar effects on water temperature in the Middle and Lower Klamath River Estuary as those described under the existing condition (see Section 3.2.2.2 *Water Temperature*), where spring, summer, and fall water temperatures would continue to be influenced by the thermal mass of Copco No. 1 and Iron Gate reservoirs, and the seasonal stratification patterns of the two reservoirs. It is unclear what, if any, steps could reduce the impact of the reservoirs on the thermal regime within the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam and comply with the Thermal Plan's ban on elevated temperature discharges into COLD interstate waters (Table 3.2-4). As discussed above, short-term and long-term potential impacts on water temperature due to implementation of the 2017 court-ordered flushing and emergency dilution flows under this alternative would be similar to the potential short-term impacts on water temperature under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-1). Flushing and emergency dilution releases could temporarily accentuate the existing fall or spring shifts in water temperature that occur in the Middle Klamath River downstream of Iron Gate Dam, but this would be a less than significant change to existing water temperatures since it would only promote the existing seasonal water temperature shift for the brief time period of the flow releases.

Of the seven water quality improvement actions described in the Reservoir Management Plan[192], selective withdrawal and intake control is most focused on water temperature improvements. PacifiCorp has estimated that the maximum useable cool water volume in Copco No. 1 Reservoir in summer (approximately 3,100 acre-feet at less than 14°C and 4,800 acre-feet at less than 16°C) and the maximum volume of cold water (8°C or less) in Iron Gate Reservoir in summer (8,000 to 10,000 acre-feet) could, if selectively withdrawn from the reservoirs, decrease water temperatures immediately downstream of Iron Gate Dam by 1 to 2°C for up to 1.5 months in late summer/early fall, with larger releases resulting in cooler water temperatures in the tailrace of the dam, but depleting the reservoir cool water pools more rapidly (PacifiCorp 2014). PacifiCorp has also noted that the water supply for Iron Gate Hatchery withdraws cold water from the deeper portion of Iron Gate reservoir, and depleting or exhausting this cold water pool during the summer would have effects on the hatchery that would need to be addressed (PacifiCorp 2014). In 2015, PacifiCorp installed a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11. One of the purposes of the curtain is to isolate warmer, less dense near-surface waters while withdrawing cooler, denser, and deeper waters from the reservoir for release to the Klamath River downstream (PacifiCorp 2018). The other purpose is to isolate surface waters that have high concentrations of blue-green algae (cyanobacteria) such that extensive summer and fall blooms are not readily released downstream to the Middle and Lower Klamath River (see further discussion in Potential Impact 4.2.2-4). Results from the intake barrier/thermal curtain indicate that modest 1–2°C (1.8–3.6°F) water temperature improvement is possible (PacifiCorp 2017), although data do not indicate that this measure could achieve compliance with the Thermal Plan or to meet the Klamath TMDLs temperature requirement in the Middle Klamath River (North Coast Regional Board (2010).

In the long term, the Klamath River TMDL model indicates that, absent climate change, as implementation of the TMDL progresses under a Continuing Operations with Fish Passage Alternative (the “TMDL dams-in” [T4BSRN] scenario), water temperatures from Iron Gate Dam (RM 193.1) to the Klamath River Estuary (RM 0−2) would improve towards modeled natural conditions (the “TMDL natural conditions” [T1BSR] scenario) (North Coast Regional Board 2010). However, some delayed warming of springtime water temperatures (February–March) and delayed cooling of late summer/fall (August–November) water temperatures would still occur under a dams-in scenario due to the large thermal mass of Copco No. 1 and Iron Gate reservoirs. With dams in-place, this temporal shift would continue to occur from downstream of Iron Gate Dam to approximately the confluence of the Salmon River (RM 66). This is because while full attainment of the Klamath River TMDLs would improve water temperature, the model is unable to demonstrate full temperature compliance in the spring and fall downstream from Iron Gate Dam to the Salmon River with the Lower Klamath Project complexes in place. The Klamath TMDL model also predicts that, with full implementation, reduced diel variation in water temperature downstream from Iron Gate Dam would continue to occur should the dams remain in place due to the thermal mass of the reservoirs. The magnitude of diel variation would increase with distance downstream from Iron Gate Dam as the river approaches equilibrium with ambient air temperatures (North Coast Regional Board 2010, Dunsmoor and Huntington 2006).

In the long term, climate change is expected to cause general increases in water temperatures. The historical data record indicates that mainstem water temperatures have increased, on average, approximately 0.05ºC (0.09ºF) per year between 1962 and 2001 (Bartholow 2005) such that climate change may already be affecting Klamath River water temperatures. Projecting the Bartholow (2005) estimate of an average annual temperature increase 50 years into the future, water temperatures would increase approximately 2–3°C (3.6–5.4°F). As part of the Klamath Dam Removal Secretarial Determination studies, the effects of climate change were included in model projections for future water temperatures under dams in and dams out scenarios. RBM10 model results using climate change predictions from five global circulation models (GCMs) indicate that future water temperatures in the Middle and Lower Klamath River under a scenario where the Lower Klamath Project dams remain in place (where simulated flows are subject to the 2010 Biological Opinion mandatory flow regime [NOAA Fisheries Service 2010]) would be 1–2.3°C (1.8–4.1 °F) warmer than historical temperatures at the end of the 50-year analysis period (Perry et al. 2011). While this temperature range is slightly lower than that suggested using the Bartholow (2005) historical estimates, within the general uncertainty of climate change projections, the two projections correspond reasonably well. Considering together the available sources for climate change predictions, annual average water temperatures in the Middle and Lower Klamath River are expected to increase within the period of analysis on the order of 1–3 °C (1.8–5.4 °F).

The anticipated increases in water temperatures due to climate change would also occur over a timescale of decades and would act in opposition to improvements expected from actions taken in furtherance of TMDL implementation in upstream reaches (see also discussion above in *Hydroelectric Reach*). While full implementation of the Klamath TMDLs is anticipated to result in late summer/fall reductions in water temperature in the range of 2–10ºC immediately downstream from Iron Gate Dam (North Coast Regional Board 2010), there is currently no reasonable proposal to achieve the temperature allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place.

In light of the ability of the thermal curtain/intake barrier to result in modest temperature improvements downstream of Iron Gate Dam during the past several years (PacifiCorp 2017, 2018), this analysis assumes that reasonably foreseeable late summer/fall water temperature improvements under the Continued Operations with Fish Passage Alternative would be on the lower end of the 2–10ºC range. Any improvements in late summer/fall water temperatures due to partial TMDL implementation would be completely offset by climate change increases of 1–3°C, and overall, under the Continued Operations with Fish Passage Alternative, late summer/fall water temperature conditions would not move towards a condition that supports designated beneficial uses, including cold freshwater habitat (COLD), rare, threatened, or endangered species (RARE), and migration of aquatic organisms (MIGR) (North Coast Regional Board 2010) in the Middle Klamath River to approximately the confluence of the Salmon River.

In summary, continued impoundment of water in Copco No. 1 and Iron Gate reservoirs under the Continued Operations with Fish Passage Alternative would maintain existing adverse late summer/fall water temperatures in the Middle Klamath River from Iron Gate Dam to the Salmon River (Section 3.2.2.2 *Water Temperature*). There is currently no reasonable proposal to achieve the temperature allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place, despite the modest improvements achieved to date through implementation of the Reservoir Management Plan (see discussion in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1). Further, long-term climate change-induced increases in water temperatures would partially offset any TMDL improvements. Overall, the Continued Operations with Fish Passage Alternative would result in no significant change from existing adverse conditions in the Middle Klamath River from Iron Gate Dam to the Salmon River and would continue to cause an exceedance of water quality standards as set forth in the Thermal Plan.

Temperature effects of the dams do not extend downstream of the Salmon River confluence (see Section 3.2.2.2 *Water Temperature*). Therefore, there would be no change in the impact of the Continuing Operations with Fish Passage Alternative in the Middle and Lower Klamath River reaches downstream from the confluence with the Salmon River, including the Klamath River Estuary and the Pacific Ocean nearshore environment.

Significance

Beneficial in the short term and long term for the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir

No significant impact in the short term and long term for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, the Middle Klamath River, the Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment

4.4.2.2 Suspended Sediments

The Continued Operations with Fish Passage Alternative would not release sediments stored behind the Lower Klamath Project dams because this alternative would not remove the existing dams. Potential Impacts 3.2-3 and 3.2-4, as discussed under the Proposed Project, would not occur and there would be no significant impacts.

The Continued Operations with Fish Passage Alternative would result in no change from the existing condition with respect to interception and retention of mineral (inorganic) suspended material in the Lower Klamath Project reservoirs (Potential Impact 3.2-6), in either the short or the long term.

J.C. Boyle gravel placement and/or habitat enhancement (IM7) (Table 4.2-1) would not continue under the Continued Operations with Fish Passage Alternative. Thus, any incidental sediment release occurring under the existing condition as a result of this activity would cease. Because of construction management practices employed, this currently does not cause a meaningful degree of sedimentation in the river, and so ceasing this practice would be unlikely to cause a substantial benefit in reducing suspended sediments.

Nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions with respect to long-term seasonal increases in algal-derived (organic) suspended material due to algal blooms in the reservoirs. There are two exceptions to this general expectation. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. These differences are discussed under a new impact heading below (Potential Impact 4.2.2-2), along with consideration of flow changes under this alternative.

The Continued Operations with Fish Passage Alternative also includes 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam that would increase SSCs compared to existing conditions during these releases. Potential short-term and long-term impacts to suspended sediments under this alternative due to these flow releases would be the same as the potential short-term impacts discussed for the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-3) and there would be no significant impact.

Additionally, the Continued Operations with Fish Passage Alternative would include upstream and downstream fish passage construction at all four Lower Klamath Project dams over a four- to eight-year period, and potential impacts related to these construction activities are discussed under a new impact heading below (Potential Impact 4.4.2-1).

Potential Impact 4.2.2-2 Seasonal increases in algal-derived (organic) suspended material due to continued impoundment of water in the reservoirs.

The Continued Operations with Fish Passage Alternative would result in no change from existing conditions with respect to interception, decomposition, retention, and/or dilution[193] of algal-derived (organic) suspended material originating from Upper Klamath Lake (in Oregon) within J.C. Boyle Reservoir and the Hydroelectric Reach to Copco No. 1 Reservoir (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). With its shallow depth and short residence time, J.C. Boyle Reservoir does not provide suitable habitat for seasonal phytoplankton (including blue-green algae) blooms (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). Increased minimum flows in the J.C.

[193] Dilution from coldwater springs downstream of J.C. Boyle Dam.

Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse under this alternative would not affect the ongoing mechanical breakdown of algal remains in the turbulent river reaches between J.C. Boyle and Copco No. 1 reservoirs or dilution by the coldwater springs located there. The breakdown and dilution of algal-derived (organic) suspended material in this portion of the Hydroelectric Reach is not an adverse existing condition and there would be no significant impact of the Continued Operations with Fish Passage Alternative on algal-derived (organic) suspended material in this reach.

However, the Continued Operations with Fish Passage Alternative would continue to result in the same adverse seasonal increases in algal-derived (organic) suspended material in Copco No. 1 and Iron Gate reservoirs as existing conditions, with subsequent release of suspended material to the Middle and Lower Klamath River, and eventually the Klamath River Estuary (Section 3.2.2.3 *Suspended Sediments*). Note that the increase in minimum flows for the Copco No. 2 Bypass Reach under this alternative could increase summertime algal-derived (organic) suspended material in the Bypass Reach relative to existing conditions if the water were to be withdrawn from the Copco No. 1 Reservoir surface waters during an intensive bloom period. However, there is no information indicating whether the water would be withdrawn from surface waters, and therefore this potential is too speculative to evaluate further.

The 2007 FERC EIS found that PacifiCorp's proposal for relicensing of the Klamath Hydroelectric Project failed to address the project's water quality impairments within and downstream of the Hydroelectric Reach (FERC 2007). Since 2007, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms. Of the seven water quality improvement actions described in the Reservoir Management Plan[192], surface water mixing and application of algaecides are focused on reduction of seasonal algae blooms in the reservoirs. Study results from physical mixing to reduce phytoplankton growth within Mirror Cove in Iron Gate Reservoir indicated that the combination of a barrier curtain, aeration, and pumping, reduced summertime phytoplankton growth in the localized area of the cove (Austin et al. 2016, PacifiCorp 2018). Treatment of blue-green algae blooms in Long Gulch Cove in Iron Gate Reservoir using a hydrogen-peroxide-based algaecide resulted in short-term reductions in phytoplankton and chlorophyll-*a* in the localized area of the cove; however, nutrient release following algaecide application may have supported a later season bloom (PacifiCorp 2013, 2014, 2015). In 2015, PacifiCorp installed a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11. One of the purposes of the curtain is to isolate surface waters that have high concentrations of blue-green algae (cyanobacteria) such that extensive summer and fall blooms are not readily released downstream to the Middle and Lower Klamath River (PacifiCorp 2018). The other purpose is to isolate warmer, less dense near-surface waters while withdrawing cooler, denser, and deeper waters from the reservoir for release to the Klamath River downstream (see further discussion in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1). Results from the intake barrier/thermal curtain indicate that the curtain reduces entrainment of blue-green algae into the Iron Gate Powerhouse intake and subsequent release downstream into the Klamath River (PacifiCorp 2017), although data do not indicate that this measure could improve algal-derived (organic) suspended material in the reservoirs such that they would no longer cause an exceedance of water quality standards (Table 3.2-4) or achieve the Klamath TMDLs phytoplankton chlorophyll-*a* target of 10 ug/L for Copco No.1 and Iron Gate reservoirs during the May to October growth season (North Coast Regional Board 2010).

Nutrient reduction measures in Oregon's Upper Klamath River and Lost River TMDLs could, over time, decrease algal-derived (organic) suspended material in Copco No.1 and Iron Gate reservoirs due to decreased nutrient availability. Similarly, nutrient reduction measures in California's Lower Lost River TMDLs and Klamath River TMDLs for organic enrichment/low dissolved oxygen, nutrients, and microcystin water quality impairments, could decrease algal-derived (organic) suspended material in Copco No.1 and Iron Gate reservoirs and could, in the long term, be beneficial to water quality. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions and subsequent effects on the Lower Klamath Project reservoirs are likely to require decades to achieve. Further, continuing seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that subsequently die and settle to the bottom, would continue to build up nutrients and organic matter in the reservoir sediments. This layer of nutrients would continue to be recycled into the water column (through internal nutrient loading, see Figure 3.2-2) during periods of stratification and low dissolved oxygen and would continue to stimulate large seasonal phytoplankton blooms in the reservoirs that are then released to the Middle and Lower Klamath River. Warmer water temperatures under climate change (Perry et al. 2011, Bartholow 2005; see discussion in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1) would further exacerbate increases in algal-derived suspended material under the Continued Operations with Fish Passage Alternative through earlier reservoir water column stratification in the spring, which provides more favorable conditions for the growth of blue-green algae.

Overall, despite the modest improvements achieved to date for localized reductions in seasonal phytoplankton blooms within Iron Gate Reservoir and reduced release of blue-green algae blooms downstream into the Klamath River, there is currently no reasonable proposal to achieve the Klamath TMDLs phytoplankton chlorophyll-*a* target of 10 ug/L for the Lower Klamath Project Reservoirs during the May to October growth season (North Coast Regional Board 2010). Overall, the Continued Operations with Fish Passage Alternative would result in no meaningful change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, the Middle and Lower Klamath River, and the Klamath River Estuary.

Significance

No significant impact in the short term and long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

Potential Impact 4.4.2-1 Short-term increases in suspended material and contaminants from stormwater runoff due to construction activities associated with replacement and construction of new fish passage facilities.

Under the Continuing Operations with Fish Passage alternative, there is the potential for impacts to water quality from construction activities associated with building new fish passage facilities, including upstream fish ladders, spillway modifications, tailrace barriers, screens, and bypass structures (see Appendix U of this EIR for more details). This alternative also includes removal of the existing J.C. Boyle fish ladder structure, construction of a new fishway at or near the same location as the existing fish ladder (Figure 2.3-1), and construction of downstream fish passage. All these construction activities could result in the disturbance of soil within the Limits of Work and result in loose sediment that could then be suspended during rainfall events in stormwater runoff. Additionally, use of heavy construction equipment and construction-related vehicles involves gasoline, other petroleum fuels, hydraulic and lubricating fluids and other materials that have the potential to contaminate waters should they be captured in stormwater runoff or due to accidents. Further, because some of the construction activities under this alternative would occur directly in the river channel (i.e., "in-water") or on the banks immediately surrounding the river, the potential for discharges to the Klamath River are greater than for work conducted in areas that can be dewatered or dried. Potential water quality impacts would occur over a four- to eight-year period (see also Section 4.4.1 *[Continued Operations with Fish Passage Alternative] Introduction*) and would be likely to cause an exceedance in water quality standards for suspended material, sediment, turbidity, and/or chemical constituents (Table 3.2-4), which would be a significant impact. Implementation of mitigation measures WQ-1, TER-1, and HZ-1 would reduce impacts to less than significant for fish passage construction-related activities in the Hydroelectric Reach throughout the four- to eight-year construction period under the Continued Operations with Fish Passage Alternative. If instead of fish ladders, trap and haul were used, there would be the potential for reduced construction compared to the aforementioned activities for fish ladders.

Significance
No significant impact with mitigation in the short term for the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam

4.4.2.3 Nutrients

The Continued Operations with Fish Passage Alternative would not release sediment-associated nutrients stored behind the Lower Klamath Project dams because this alternative would not remove the existing dams (Potential Impact 3.2-7) and there would be no significant impact.

The Continued Operations with Fish Passage Alternative would generally result in no change from the existing condition with respect to interception and retention of nutrients in the Lower Klamath Project reservoirs, in either the short term or the long term. There are two exceptions to this general statement. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. These differences are discussed under a new impact heading below (Potential Impact 4.2.2-4), along with consideration of flow changes under this alternative.

Potential Impact 4.2.2-4 Annual interception and retention of nutrients and seasonal release of nutrients due to continued impoundment of waters in the reservoirs.
The Continued Operations with Fish Passage Alternative would continue to result in the same small annual decreases in total phosphorus (TP) and total nitrogen (TN) across the Hydroelectric Reach as occur under existing conditions, due to settling of particulate matter and retention of associated nutrients originating from upstream reaches, including Upper Klamath Lake (in Oregon), in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs, and dilution by the coldwater springs located downstream of J.C. Boyle Reservoir

(Section 3.2.2.4 *Nutrients*). Increased minimum flows in the J.C. Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse under this alternative would not be expected to change the longitudinal decrease in total particulate nutrients on an annual basis from J.C. Boyle Reservoir to Iron Gate Reservoir (i.e., the Hydroelectric Reach).

However, this alternative would also continue to support the same seasonal increases in TP, and to a lesser degree TN, in the Hydroelectric Reach due to the release (export) of dissolved forms of phosphorus (ortho-phosphorus) and nitrogen (ammonium) from Copco No. 1 and Iron Gate reservoir sediments during summer and fall, when reservoir bottom waters are anoxic (through internal nutrient loading, see Figure 3.2-2). These nutrients can stimulate large seasonal blooms of phytoplankton, including blue-green algae, that are then released to the Middle and Lower Klamath River, and eventually the Klamath River Estuary (Section 3.4.2.1 *Phytoplankton*). Seasonal TP can also be transported downstream to the Middle Klamath River where it can stimulate excessive growth of periphyton (aquatic freshwater organisms attached to river bottom surfaces) (Section 3.4.2.2 *Periphyton*). Further downstream, the nutrient effects of the Lower Klamath Project diminish due to both tributary dilution and nutrient retention, such that effects are likely to be small in the Lower Klamath River and Klamath River Estuary (see Potential Impact 3.2-9). Thus, this impact focuses on seasonal nutrient trends in the Hydroelectric Reach and the Middle Klamath River under the Continued Operations with Fish Passage Alternative. Increasing minimum flows for the Copco No. 2 Bypass Reach would not change existing conditions with respect to annual or seasonal nutrient trends in this reach.

The 2007 FERC EIS found that PacifiCorp's proposal for relicensing of the Klamath Hydroelectric Project failed to address the project's water quality impairments within and downstream of the Hydroelectric Reach (FERC 2007). Since 2007, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams. Of the seven water quality improvement actions described in the Reservoir Management Plan[194], conceptual design and implementation of constructed wetlands and design and implementation of in-reservoir oxygenation systems have potential to reduce the seasonal release of nutrients from reservoir bottom sediments by intercepting incoming nutrients from upstream sources before they can enter the reservoirs, and by changing the chemistry of reservoir bottom waters (by physically adding oxygen) to inhibit (dissolved) nutrient release from the sediments.

PacifiCorp has conducted studies to determine the feasibility and effectiveness of constructing treatment wetlands upstream along the Upper Klamath River (e.g., along Lake Ewauna/Keno Impoundment) (Lyon et al. 2009, CH2M HILL 2012, PacifiCorp 2013), as well as along Copco No. 1 and Iron Gate reservoirs. PacifiCorp proposed a

[194] Water quality management techniques in the Reservoir Management Plan (PacifiCorp 2014b) for application in Copco No. 1 and Iron Gate reservoirs include the following techniques to control nutrients, algae, dissolved oxygen and pH: (1) constructed wetlands conceptual design and implementation planning; (2) further evaluation of tailrace aeration and oxygenation systems; (3) design and implementation planning of in-reservoir oxygenation systems; (4) evaluation of epilimnion (surface water) mixing and circulation; (5) further evaluation of selective withdrawal and intake control; (6) modeling and testing of deeper seasonal drawdown and fluctuation of the reservoirs; and (7) additional testing and controlled applications of SCP algaecide to treat localized areas (e.g., coves, embayments) in the reservoirs.

design for a demonstration wetlands facility adjacent to the Upper Klamath River, evaluated five potential sites, and developed construction costs and a monitoring plan (PacifiCorp 2018). To date PacifiCorp has not implemented the demonstration facility, although PacifiCorp has continued to fund pilot studies of diffuse source (i.e., small distributed) treatment wetlands for reducing nutrient transport into Upper Klamath Lake, which would eventually help to improve water quality conditions downstream in the Klamath River. PacifiCorp has also tested chemical coagulants at the laboratory scale to assess the potential for binding and removing phosphorus from waters entering the Lower Klamath Project reservoirs. While some of the coagulants were effective, potential toxicity to aquatic organisms was indicated in the laboratory tests due to elevated dissolved aluminum levels (PacifiCorp 2018). Other Reservoir Management Plan studies have included consideration of in-reservoir oxygenation systems for Keno, J.C. Boyle, and Iron Gate reservoirs (MEI 2007, PacifiCorp 2014, 2018); however, results of the aforementioned studies do not indicate that these approaches, either individually or in combination, would allow the reservoirs to meet Klamath TMDL targets for nutrients (TP and TN) for the tailraces of Copco No. 2 and Iron Gate dams, where these targets numerically interpret the narrative biostimulatory substances objective for the Klamath River (see Section 3.2.3.1 *Thresholds of Significance – Nutrients*).

Nutrient reduction measures in Oregon's Upper Klamath River and Lost River TMDLs would, over time, decrease nutrient input to the Lower Klamath Project reservoirs. Similarly, nutrient reduction measures in California's Lower Lost River TMDLs and Klamath River TMDLs for nutrients would decrease nutrient inputs and would, in the long term, be beneficial to water quality. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions, along with the corresponding reductions in nutrient inflows to the Lower Klamath Project are likely to require decades to achieve. Further, continuing seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that subsequently die and settle to the bottom, would continue to build up nutrients and organic matter in the reservoir sediments. This layer of nutrients would continue to be recycled into the water column (through internal nutrient loading, see Figure 3.2-2) during periods of stratification and low dissolved oxygen and would continue to stimulate large seasonal phytoplankton blooms in the reservoirs that are then released to the Middle Klamath River. Warmer water temperatures under climate change (Perry et al. 2011, Bartholow 2005; see discussion in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1) would further exacerbate seasonal nutrient internal loading by supporting earlier reservoir water column stratification in the spring and later water column mixing in the fall, for an overall longer period of anoxia in bottom waters and opportunity for seasonal nutrient release to the Hydroelectric Reach and the Middle Klamath River.

With respect to the potential impact of 2017 court-ordered flushing and emergency dilution flows on nutrients downstream of Iron Gate Dam under the Continued Operations with Fish Passage Alternative, since suspended sediments transported by these releases would be primarily mineral (inorganic) sediments there would be no change from existing conditions for nutrients due to implementation of these flows. Flushing and emergency dilution releases downstream of Iron Gate Dam would end by June 15, which is generally before large phytoplankton (e.g., blue-green algae) blooms occur in Iron Gate Reservoir under existing conditions (E&S Environmental Chemistry, Inc. 2013, 2014, 2015, 2016, 2018a, 2018b), so releases would result in a less than significant increase in the export phytoplankton cells and associated nutrients downstream of Iron Gate Dam for the reasons described for the No Project Alternative

(Section 4.2.2, Potential Impact 4.2.2-4 and Section 4.2.4.1 *Phytoplankton*). Increasing minimum flows for the Copco No. 2 Bypass Reach under this alternative also would not change existing conditions with respect to annual or seasonal nutrient trends in the Hydroelectric Reach or the Klamath River downstream of Iron Gate Dam.

There is currently no reasonable proposal to achieve the Klamath TMDLs targets for nutrients (TP and TN) for the tailraces of Copco No. 2 and Iron Gate dams, where these targets numerically interpret the narrative biostimulatory substances objective. Overall, the Continued Operations with Fish Passage Alternative would result in no significant change from existing adverse conditions with respect to seasonal release of nutrients and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach and the Middle Klamath River in the short term and long term.

Significance

No significant impact in the short term and long term for annual interception and retention of nutrients in the Hydroelectric Reach

No significant impact in the short term and long term for seasonal release of nutrients to the Hydroelectric Reach and the Middle Klamath River

4.4.2.4 Dissolved Oxygen

The Continued Operations with Fish Passage Alternative would not release sediments stored behind the Lower Klamath Project dams because this alternative would not remove the existing dams. Thus, there would be no short-term depletion of oxygen from the river due to resuspension of unoxidized organic matter during drawdown (Potential Impact 3.2-10) and there would be no significant impact.

The Continued Operations with Fish Passage Alternative would result in no change from the existing adverse condition with respect to large summertime variations in dissolved oxygen in the Hydroelectric Reach and dissolved oxygen concentrations in the Middle Klamath River immediately downstream of Iron Gate Reservoir that fall below the Basin Plan minimum dissolved oxygen criteria (Section 3.2.2.5 *Dissolved Oxygen*), in either the short or the long term. There are two exceptions to this general expectation. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. The 2007 FERC EIS found that PacifiCorp's proposal for relicensing of the Klamath Hydroelectric Project failed to address the project's water quality impairments within and downstream of the Hydroelectric Reach (FERC 2007). The Klamath River TMDLs later assigned water temperature and dissolved oxygen dual (i.e., co-occurring) load allocations to Copco No. 1 and Iron Gate reservoirs for the stratification period (May through October) to ensure compliance with the dissolved oxygen and water temperature targets (i.e., dissolved oxygen consistent with 85 percent saturation or better through September, and 90 percent or better in October [see also Table 3.2-5]) within the reservoirs and to ensure support of COLD. The Klamath River TMDLs created a physical "compliance lens" where both dissolved oxygen and temperature conditions meet Basin Plan objectives in a layer of water stretching from the point of entry to the reservoirs throughout the reservoir (the depth of the compliance lens within the reservoir is not fixed) (North Coast Regional Board 2010). Since 2007, PacifiCorp has developed several iterations of a

Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including dissolved oxygen. Study results, including those under IM 11 (see Table 4.2-1), have indicated that while proposed reservoir management techniques can improve some of the project impacts to water quality (e.g., transport of nuisance and/or noxious blue-green algae downstream of Iron Gate Dam [Austin et al. 2016, PacifiCorp 2018]), the various techniques have not resulted in water quality improvements at Copco No. 1 or Iron Gate reservoirs that create the TMDL compliance lens nor have they otherwise sufficiently improved Lower Klamath Project impacts to dissolved oxygen (Section 3.2.2.5 *Dissolved Oxygen*). Results from operation of a turbine venting system at Iron Gate Dam indicate that dissolved oxygen improvement is possible using this technique; Potential Impact 4.2.2-5 below discusses these results, along with consideration of flow changes under this alternative.

Potential Impact 4.2.2-5 Seasonal low dissolved oxygen concentrations due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

The Continued Operations with Fish Passage Alternative would continue to result in the same large summertime variations in dissolved oxygen in J.C. Boyle Reservoir, especially at depth, where summer/late fall concentrations can fall below 5 mg/L, releasing water with low dissolved oxygen concentrations to the Klamath River immediately downstream of J.C. Boyle Dam (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.1*). Increased minimum flows in the J.C. Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse under this alternative would result in more natural flow conditions, which could have no effect or potentially a small effect on average dissolved oxygen concentrations in the Hydroelectric Reach downstream of J.C. Boyle Dam and at the Oregon-California state line, and somewhat reduced variability in daily dissolved oxygen for this same reach. These results are predicted by the Klamath River TMDL model, which is useful for informing impacts associated with the Proposed Project and alternatives, although it includes as a starting assumption that there will be full implementation of the TMDLs (see further discussion of TMDLs below). Overall, since daily variability in dissolved oxygen is not currently an issue in the J.C. Boyle Peaking Reach, slightly reducing this variability under future conditions where there is full implementation of the TMDLs would not be considered a beneficial effect under this alternative. Instead, there would be no change from existing adverse conditions for dissolved oxygen during summer months immediately downstream of J.C. Boyle Dam.

In Copco No. 1 and Iron Gate reservoirs, this alternative would continue to result in the same adverse seasonal anoxia (0 mg/L dissolved oxygen) in reservoir bottom waters, which often occurs by May and lasts through October to early November (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.1*). Of the seven water quality improvement actions described in the Reservoir Management Plan[192], in-reservoir oxygenation of J.C. Boyle Reservoir or the upstream Lake Ewauna/Keno Impoundment have potential to increase seasonal dissolved oxygen in J.C. Boyle Reservoir bottom waters indirectly, by reducing oxygen demand of waters entering J.C. Boyle Reservoir, or directly, by adding oxygen to J.C. Boyle Reservoir (PacifiCorp 2014, 2018). Further downstream in Iron Gate Reservoir, in-reservoir oxygenation could directly increase seasonal dissolved oxygen without depleting or exhausting the cold water pool in Iron Gate Reservoir that is used for the Iron Gate Hatchery water supply (see also discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1). PacifiCorp undertook a feasibility study for this reservoir, which indicated that placement of a hypolimnetic (bottom water) bubble-type oxygenation system near Iron Gate Dam could result in well-oxygenated conditions in the Iron Gate Powerhouse releases to the Middle Klamath River (PacifiCorp 2014, MEI 2007); however, this approach did not demonstrate creation of the TMDL compliance lens compliance within the remainder of the reservoir and the study raised questions regarding financial feasibility. To date implementation of in-reservoir oxygenation in the Lower Klamath Project reservoirs has not occurred. In 2015, PacifiCorp installed a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11. One of the purposes of the curtain is to isolate warmer, less dense near-surface waters while withdrawing cooler, denser, and deeper waters from the reservoir for release to the Klamath River downstream (PacifiCorp 2018). The other purpose is to isolate surface waters that have high concentrations of blue-green algae (cyanobacteria) such that extensive summer and fall blooms are not readily released downstream to the Middle and Lower Klamath River (see further discussion in Section 4.4.2 *[Continued Operations with Fish Passage] Suspended Sediments*, Potential Impact 4.2.2-2). Results from deployment of the intake barrier/thermal curtain in 2016 indicate that the presence of the curtain can reduce mixing of reservoir surface waters near the curtain such that moderate (5 to 6 mg/L) to low (approximately 2 to 5 mg/L) dissolved oxygen concentrations occur at depths from 2 to 12 meters due to respiration of dense phytoplankton blooms (PacifiCorp 2017). Overall, while results from the Reservoir Management Plan feasibility investigations of in-reservoir oxygenation and deployment of an intake barrier/thermal curtain suggest that improvement in dissolved oxygen is possible in the reservoirs (PacifiCorp 2017, 2018), these studies have not resulted in water quality improvements at Copco No. 1 or Iron Gate reservoirs that meet TMDL requirements for dissolved oxygen in the reservoirs, nor have they otherwise sufficiently improved Lower Klamath Project impacts to dissolved oxygen in the Middle Klamath River immediately downstream of Iron Gate Dam (see below discussion under *Middle and Lower Klamath River and Klamath River Estuary*). There would be no change from existing conditions with respect to dissolved oxygen due an increase in the minimum flows for the Copco No. 2 Bypass Reach.

Nutrient reduction measures in Oregon's Upper Klamath River and Lost River TMDLs would, over time, decrease nutrient input to the Lower Klamath Project reservoirs which would reduce the prevalence of anoxic conditions in reservoir bottom waters during periods of stratification under existing conditions (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*). Similarly, nutrient reduction measures in California's Lower Lost River TMDLs and Klamath River TMDLs for nutrients would decrease nutrient inputs and would, in the long term, be beneficial to water quality by improving seasonal dissolved oxygen in the reservoirs. However, it is anticipated that full attainment of the Oregon and California TMDLs would require decades to achieve. Further, continuing seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs, which subsequently die and settle to the bottom, would continue to result in zero to low dissolved oxygen in bottom waters during periods of stratification (see Figure 3.2-2), which is then released to the Middle Klamath River (see below discussion under *Middle and Lower Klamath River and Klamath River Estuary*). Warmer water temperatures under climate change (Perry et al. 2011, Bartholow 2005; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1) would further exacerbate low dissolved oxygen concentrations in reservoir bottom waters by supporting earlier reservoir water column stratification in the spring and later water column mixing in the fall, for an overall longer period of anoxia in bottom waters and releases of water with low dissolved oxygen concentrations to the Middle Klamath River.

There is currently no reasonable proposal to achieve the Klamath TMDLs compliance lens for dissolved oxygen in Copco No. 1 and Iron Gate reservoirs or Basin Plan minimum dissolved oxygen criteria (minimum dissolved oxygen criteria of 85 percent saturation for the period April 1 through September 30, and below the minimum criterion of 90 percent saturation for the period October 1 to March 31, for the Klamath River from Oregon-California state line [RM 214.1] to the Scott River [RM 145.1]; Table 3.2-4) with the dams remaining in place, despite the modest improvements achieved to date through implementation of the Reservoir Management Plan. Overall, the Continued Operations with Fish Passage Alternative would not resolve the existing adverse conditions and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach.

Middle and Lower Klamath River and Klamath River Estuary

As discussed above, the Continued Operations with Fish Passage Alternative would continue to result in the same seasonal anoxia (0 mg/L dissolved oxygen) in reservoir bottom waters during periods of stratification (July through October/November) in Copco No. 1 and Iron Gate reservoirs as existing conditions (see also Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.1*). Immediately downstream of Iron Gate Dam, this alternative would continue to result in low dissolved oxygen in waters released from Iron Gate Reservoir during summer/late fall months, where concentrations regularly fall below 8.0 mg/L and the current Basin Plan minimum dissolved oxygen criteria based on percent saturation[195] (see also Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*). Alterations in dissolved oxygen concentrations due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would result in no significant impacts for the reasons described under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-5). Further downstream, the effects of the Lower Klamath Project on dissolved oxygen diminish due to natural stream re-aeration, such that effects are not generally discernable by Seiad Valley (RM 132.7) (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*). Thus, this impact focuses on dissolved oxygen trends in the Hydroelectric Reach and the Middle Klamath River from Iron Gate Dam to Seiad Valley (RM 132.7) under the Continued Operations with Fish Passage Alternative. For the Middle Klamath River downstream of Seiad Valley (RM 132.7), the Lower Klamath River, and the Klamath River Estuary, there would be no significant impact of the Continued Operations with Fish Passage Alternative.

Of the seven water quality improvement actions described in the Reservoir Management Plan[194], tailrace aeration and oxygenation, in-reservoir oxygenation, and selective withdrawal and intake control have potential to increase seasonal dissolved oxygen in the Middle Klamath River immediately downstream of Iron Gate Dam by physically adding oxygen to reservoir waters or pulling higher oxygen water from selected depths in the water column for downstream release, while avoiding low oxygen water. In-reservoir oxygenation is described above for the *Hydroelectric Reach*. With respect to tailrace

[195] Minimum dissolved oxygen criteria of 85 percent saturation for the period April 1 through September 30, and below the minimum criterion of 90 percent saturation for the period October 1 to March 31, for the Klamath River from Oregon-California state line (RM 214.1) to the Scott River (RM 145.1); see also Table 3.2-4.

aeration/oxygenation, PacifiCorp currently (since 2009), and on a year-round basis, automatically operates a turbine venting system with a blower that mechanically adds oxygen as water is passed through the powerhouse turbines, with the goal of improving dissolved oxygen concentrations immediately downstream from the dam during periods of reservoir stratification. The system is automatically turned on when dissolved oxygen levels drop below 87 percent saturation and is automatically turned off when dissolved oxygen levels exceed 87 percent saturation. Despite improvements reported during 2008 and 2011, dissolved oxygen immediately downstream of Iron Gate Dam has continued to exhibit percent saturation values below the Basin Plan minimum dissolved oxygen criteria of 85 percent saturation for the period April 1 through September 30, and below the minimum criterion of 90 percent saturation for the period October 1 to March 31 for the Klamath River from Oregon-California state line (RM 214.1) to the Scott River (RM 145.1) (see also Table 3.2-4), with the majority of measured low dissolved oxygen saturation values occurring from August through November (see Appendix C – *Section C.4*). Dissolved oxygen concentrations improve with natural aeration as water moves downstream such that within approximately 6 miles downstream of the dam, the effect of turbine venting is no longer discernable (PacifiCorp 2011).

In 2015, PacifiCorp installed a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11. One of the purposes of the curtain is to isolate warmer, less dense near-surface waters while withdrawing cooler, denser, and deeper waters from the reservoir for release to the Klamath River downstream (PacifiCorp 2018). The other purpose is to isolate surface waters that have high concentrations of blue-green algae (cyanobacteria) such that extensive summer and fall blooms are not readily released downstream to the Middle and Lower Klamath River (see further discussion in Section 4.4.2.2 *[Continued Operations with Fish Passage] Suspended Sediments,* Potential Impact 4.2.2-2). Results from deployment of the intake barrier/thermal curtain in 2016 indicate that the presence of the curtain can reduce mixing of reservoir surface waters near the curtain such that low dissolved oxygen concentrations are entrained in the powerhouse intake, and to date turbine venting does not sufficiently improve dissolved oxygen concentrations in the Middle Klamath River immediately downstream of Iron Gate Dam (PacifiCorp 2018).

Overall, while results from the Reservoir Management Plan techniques employed indicate thus far that improvement is possible (PacifiCorp 2017, 2018), they have not resulted in water quality improvements at Copco No. 1 or Iron Gate reservoirs that create the TMDL compliance lens nor have they otherwise sufficiently improved Lower Klamath Project impacts to dissolved oxygen in the Middle Klamath River immediately downstream of Iron Gate Dam (North Coast Regional Board (2010).

Nutrient reduction measures in Oregon's Upper Klamath River and Lost River TMDLs would, over time, decrease nutrient input to the Lower Klamath Project reservoirs which would reduce the prevalence of anoxic conditions in reservoir bottom waters during periods of stratification under existing conditions and improve dissolved oxygen in waters discharged to the Middle Klamath River (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*). Similarly, nutrient reduction measures in California's Lower Lost River TMDLs and Klamath River TMDLs for nutrients would decrease nutrient inputs and would, in the long term, be beneficial to water quality by improving seasonal dissolved oxygen in the reservoirs and the downstream river. However, it is anticipated that full attainment of the Oregon and California TMDLs would require decades to achieve. Further, continuing seasonal phytoplankton blooms in Copco No. 1

and Iron Gate reservoirs, which subsequently die and settle to the bottom, would continue to result in low to zero dissolved oxygen in bottom waters during periods of stratification (see Figure 3.2-2) that is then released to the Middle Klamath River. Warmer water temperatures under climate change (Perry et al. 2011, Bartholow 2005; see discussion in 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature,* Potential Impact 4.2.2-1) would further exacerbate low dissolved oxygen concentrations in reservoir bottom waters by supporting earlier reservoir water column stratification in the spring and later water column mixing in the fall, for an overall longer period of anoxia in bottom waters and potential release to the Middle Klamath River.

There is currently no reasonable proposal to achieve the Klamath TMDLs compliance lens for dissolved oxygen in Copco No. 1 and Iron Gate reservoirs or Basin Plan minimum dissolved oxygen criteria (minimum dissolved oxygen criteria of 85 percent saturation for the period April 1 through September 30, and below the minimum criterion of 90 percent saturation for the period October 1 to March 31, for the Klamath River from Oregon-California state line [RM 214.1] to the Scott River [RM 145.1]; Table 3.2-4) with the dams remaining in place, despite the modest improvements achieved to date through implementation of the Reservoir Management Plan. Overall, the Continued Operations with Fish Passage Alternative would not resolve existing adverse conditions and would continue to cause an exceedance of water quality standards in the Middle Klamath River immediately downstream of Iron Gate Dam to Seiad Valley (RM 132.7).

Significance

No significant impact in the long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

4.4.2.5 pH

The Continued Operations with Fish Passage Alternative would result in no change from the existing adverse condition with respect to pH values that exceed the Basin Plan instantaneous maximum pH objective of 8.5 s.u and large daily fluctuations in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*). In the Middle and Lower Klamath River and Klamath River Estuary, pH exhibits large (0.5–1.5 pH units) daily fluctuations during periods of high photosynthesis and pH values also regularly exceed Basin Plan instantaneous maximum pH objective of 8.5 s.u. during late-summer and early-fall months (August–September), with the most extreme pH exceedances typically occurring from Iron Gate Dam to approximately Seiad Valley (see Section 3.2.2.6 *pH*). There are two exceptions to the general expectation that these adverse existing conditions would continue under this alternative. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. These differences are discussed under Potential Impact 4.2.2-6 below. Note that while the Hydroelectric Reach is not currently identified as being impaired for pH specifically and the California Klamath River TMDLs do not include specific allocations or targets for pH itself, pH is identified as a secondary indicator of biostimulation, and pH impacts (i.e., exceedances of Basin Plan numeric pH objectives, see Table 3.2-4) are closely related to excessive nutrient inputs to the Klamath River (North Coast Regional Board 2010).

Potential Impact 4.2.2-6 Seasonal high pH and daily pH fluctuations due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

The Continued Operations with Fish Passage Alternative would continue to result in the same pH values that exceed the Basin Plan instantaneous maximum pH objective of 8.5 s.u and large daily fluctuations in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*).

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality*, Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that would affect pH. The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5 do not indicate that this measure could improve phytoplankton blooms in the reservoirs such that they would no longer cause an exceedance of pH standards (Table 3.2-4). Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial to pH. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions are likely to require decades to achieve. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in the Hydroelectric Reach and overall there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated pH in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months. Overall, the Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach. There would be no change from existing conditions with respect to pH due an increase in the minimum flows for the Copco No. 2 Bypass Reach.

Middle and Lower Klamath River and Klamath River Estuary

As discussed above, the Continued Operations with Fish Passage Alternative would continue to result in continuation of pH values that exceed the Basin Plan instantaneous maximum pH objective of 8.5 s.u and large daily fluctuations in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*). Downstream of Iron Gate Dam, this alternative would continue to result in similar pH trends for periods of high photosynthesis, particularly when large phytoplankton blooms are transported from Iron Gate Reservoir into the Middle and Lower Klamath River, with the most extreme pH exceedances typically occurring from Iron Gate Dam to approximately Seiad Valley (see Section 3.2.2.6 *pH*). Alterations in pH due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would result in no significant impacts for the reasons described under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-6).

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that would affect pH. The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5 do not indicate that this measure could improve phytoplankton blooms in the reservoirs such that they would no longer cause an exceedance of pH standards in the Middle Klamath River (Table 3.2-4). Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial to pH. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions are likely to require decades to achieve. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in the Hydroelectric Reach and overall there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated pH in the Middle Klamath River, potentially extending downstream of Seiad Valley into the Lower Klamath River and Klamath River Estuary during summer and fall months. Overall, the Continued Operations with Fish Passage Alternative would result in no meaningful change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Middle and Lower Klamath River and Klamath River Estuary.

Significance

No significant impact in the long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

4.4.2.6 Chlorophyll-*a* and Algal Toxins

The Continued Operations with Fish Passage Alternative would continue to result in the same adverse, large, seasonal phytoplankton blooms, including blue-green algae, in Copco No. 1 and Iron Gate reservoirs, chlorophyll-*a* concentrations exceeding the TMDL target of 10 ug/L during the May to October growth season, and periodically high levels of algal toxins (concentrations greater than 0.8 and/or 4 ug/L microcystin[196]) (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*) as existing conditions. This alternative would also continue to result in release of chlorophyll-a and microcystin to the Middle and Lower Klamath River, and eventually the Klamath River Estuary, where longitudinal and temporal variations in microcystin concentrations from upstream of Copco No. 1 Reservoir to Turwar indicate that Iron Gate Reservoir is the principal source of *Microcystis aeruginosa* cells to the Middle and Lower Klamath River (Otten et al. 2015) (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*). There are two exceptions to the general expectation that these adverse existing conditions would continue under this alternative. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations

[196] Since the less than 4 ug/L criterion for microcystin in recreational waters is common to the California Klamath River TMDL, WHO, and Yurok Tribe criteria, and it is less than the Hoopa Valley Tribe recreational criterion, 4 ug/L microcystin is used as the threshold of significance for the Lower Klamath Project EIR water quality analysis. The current lowest CCHAB and Yurok Tribe posting limit for microcystin (0.8 ug/L) is also considered in the analysis although application of the lower threshold would in no case change the significance determinations in this EIR (see Section 3.2.3.1 *Thresholds of Significance – Chlorophyll-a and Algal Toxins*).

with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. These differences are discussed under Potential Impact 4.2.2-7 below, along with consideration of flow changes under this alternative.

Potential Impact 4.2.2-7 Seasonal increases in chlorophyll-a and algal toxins due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

While seasonal phytoplankton (including blue-green algae) blooms originating from Upper Klamath Lake (in Oregon) can enter J.C. Boyle Reservoir, the short residence time of this reservoir does not support substantial additional growth of algae (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). Increased minimum flows in the J.C. Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse under this alternative would not be expected to significantly affect this condition and there would be no significant impact of the Continued Operations with Fish Passage Alternative on chlorophyll-*a* and algal toxin concentrations in the Hydroelectric Reach from J.C. Boyle Reservoir to the upstream end of Copco No. 1 Reservoir. However, the Continued Operations with Fish Passage Alternative would continue to result in chlorophyll-*a* concentrations exceeding the TMDL target of 10 ug/L during the May to October growth season, and periodically high levels of algal toxins (concentrations greater than 0.8 and/or 4 ug/L microcystin), in Copco No. 1 and Iron Gate reservoirs and would result in no change from existing adverse conditions (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*).

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations. The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6 do not indicate that this measure could reduce the extent of phytoplankton blooms in the reservoirs such that they would no longer cause exceedances of chlorophyll-*a* and algal toxin standards. Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial with respect to decreasing these water quality constituents, although the measures to achieve such reductions remain unclear, and the improvements could require decades. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in the Hydroelectric Reach and overall there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months. Overall, the Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach. There would be no change from existing conditions with respect to chlorophyll-*a* and algal toxins due an increase in the minimum flows for the Copco No. 2 Bypass Reach.

Middle and Lower Klamath River and Klamath River Estuary

As discussed above, the Continued Operations with Fish Passage Alternative would continue to result in the same elevated chlorophyll-*a* concentrations (i.e., exceeding the TMDL target of 10 ug/L during the May to October growth season), and periodically high levels of algal toxins (concentrations greater than 0.8 and/or 4 ug/L microcystin) in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*). Downstream of Iron Gate Dam, this alternative would continue to result in similar chlorophyll-*a* and algal toxin trends when large phytoplankton blooms are transported from Iron Gate Reservoir into the Middle and Lower Klamath River and Klamath River Estuary.

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that increase chlorophyll-*a* and algal toxin concentrations when they are transported from Iron Gate Reservoir into the Middle and Lower Klamath River. The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6 do not indicate that this measure could reduce the extent of phytoplankton blooms in the upstream Lower Klamath Project reservoirs such that they would no longer cause exceedances of chlorophyll-*a* or algal toxin standards in the Middle and Lower Klamath River. Alterations in chlorophyll-a and algal toxins due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would result in no significant impacts for the reasons described under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-7).

Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial with respect to decreasing these water quality constituents, although the measures to achieve such reductions remain unclear, and the improvements could require decades. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in the Hydroelectric Reach, which would then be transported downstream, and overall there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months. Overall, the Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Middle and Lower Klamath River and Klamath River Estuary.

Significance

No significant impact in the long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

4.4.2.7 Inorganic and Organic Contaminants

The Continued Operations with Fish Passage Alternative would continue the existing condition with respect to short-term and long-term freshwater aquatic species' or human exposure to inorganic and organic contaminants (Section 3.2.2.8 *Inorganic and Organic Contaminants*).

The short-term increases in freshwater aquatic species' or human exposure to inorganic and organic contaminants associated with sediment release under the Proposed Project (Potential Impacts 3.2-13 through 3.2-15) would not occur because the dams and sediment deposits would remain in place and there would be no significant impact. There would be no significant impact to aquatic biota in the short term from herbicide application during restoration of the former reservoir areas, as the reservoirs would remain in place (Potential Impact 3.2-16). There would be no change from existing conditions in the short term or long-term with respect to changes in Iron Gate Hatchery operations on Klamath River water quality since Iron Gate Hatchery would continue existing operations (Potential Impact 3.2-17). Fall Creek Hatchery would not be reopened under this alternative and thus there would be no effects of hatchery discharges on water quality and thus no significant impact (Potential Impact 3.2-17). There would be no significant impacts on water quality from short-term construction activities on Parcel B lands since land transfer would not occur (Potential Impact 3.2-18). The potential for increases in inorganic and organic contaminants from hazardous materials associated with construction of fishways is discussed in Potential Impact 4.4.2-1.

Alterations in human and freshwater aquatic species' exposure to inorganic and organic contaminants due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would result in no significant impacts for the reasons described under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-8). Increased minimum flows in the J.C. Boyle Bypass Reach, limitation of peaking operations at J.C. Boyle Powerhouse, and increased minimum flows in the Copco No. 2 Bypass Reach would have no effect on exposure pathways for inorganic and organic contaminants because the flow changes would not alter the Lower Klamath Project reservoir sediment deposits nor would they alter physical, chemical, or biological conditions within the river or reservoir reaches that would change the potential for exposure to inorganic or organic contaminants compared with existing conditions.

4.4.3 Aquatic Resources

4.4.3.1 Suspended Sediment

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath Project dams would not be removed, and sediment would continue to be trapped and stored behind the dams. This evaluation assumes that the Continued Operations with Fish Passage Alternative would result in similar SSCs to the model runs for existing conditions. This model scenario provides the closest evaluation of the long-term suspended sediments effects of Continued Operations with Fish Passage Alternative. It results in no change to algal-derived (organic) suspended material as compared to existing condition over the long term, as the dams would continue to exert the same influence on algal-derived (organic) suspended material as under existing conditions (see also Potential Impact 4.2.2-2).

However, the modeling for the No Project Alternative somewhat underestimates the short-term SSC impacts of the Continuing Operations with Fish Passage Alternative, as it does not have SSC impacts related to the construction of fish passage facilities. As discussed in Section 4.4.2 *Water Quality – Suspended Sediments*, and specifically in Potential Impact 4.4.2-1, implementation of mitigation measures WQ-1, TER-1, and HZ-1 would reduce the potential significance of the short-term construction-related impacts to less than significant. Thus, there would be no significant impact in the short term of suspended sediment on any aquatic species under the Continued Operations with Fish Passage Alternative with mitigation. This alternative would have no long-term effects associated with suspended sediment transport for any aquatic species, relative to existing conditions.

4.4.3.2 Bed Elevation and Grain Size Distribution

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath Project dams would not be removed and sediment would continue to be stored behind Lower Klamath Project dams, as described for existing conditions in Section 3.11.2.5 Reservoir Sediment Storage and Composition. As described for existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project–Suspended Sediment*), the Lower Klamath Project dams would continue to trap fine and coarse sediment which, when transported as bedload sediments and deposited downstream, are necessary for the long-term maintenance of aquatic habitats. As of the interception of sand, gravel and coarser sediment supply from sources upstream of Iron Gate Dam the channel downstream from Iron Gate Dam would continue to coarsen and decrease in mobility (USBR 2012), providing fewer components of habitat, in particular spawning habitat, and decreased habitat quality over time. This effect would continue to gradually decrease in the downstream direction as coarse sediment is resupplied by tributary inputs (Hetrick et al. 2009) and would be substantially reduced at the Cottonwood Creek confluence (PacifiCorp 2004a). As occurs under existing conditions, the coarser bed material is mobilized at higher flows that occur less frequently, resulting in channel features that are unnaturally static and provide lower value aquatic habitat (Buer 1981), and provide stable substrate favorable for polychaetes and for C. shasta and P. minibicornis (Hetrick et al. 2009). Additionally, as described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, in 2017, the United States District Court ordered USBR to change operations to meet court-ordered flushing flows below Iron Gate Dam. These are not modeled as part of existing conditions hydrology. These flows increase bedload mobilization during the years in which they are ordered by the court.

4.4.3.3 Water Quality

Under the Continued Operations with Fish Passage Alternative, water quality would be the same as described for existing conditions (Section 3.2.2 *Water Quality*) with the modifications described in Section 4.4.2 *Water Quality*. However, unlike under existing conditions, anadromous fish would be able to move through the Hydroelectric Reach and would be seasonally exposed to poor water quality during upstream and downstream migration, and for long durations if rearing were to occur in the mainstem river. Diminished dissolved oxygen concentrations within reservoirs can be seasonally stressful for anadromous fish from June to September (FERC 2007), high levels of the cyanotoxin microcystin also occur during summer months (see Section 3.2.2.7 *Chlorophyll-a and Algal Toxins* and discussion below for more detail) and continued high rates of algal photosynthesis in the reservoirs would result in pH values that would not consistently meet applicable ODEQ and California Basin Plan water quality objectives (see Section 3.2.2.6 *pH*).

Under the Continued Operations with Fish Passage Alternative, the effects on water temperature are predicted to be similar to those described for existing conditions (Section 3.2.2.2 *Water Temperature*), with the modifications described in Section 4.4.2 *Water Quality – Water Temperature*. Under the Continued Operations with Fish Passage Alternative, the 40 percent bypass requirement at J.C. Boyle Dam would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler water temperatures in late fall and winter. These effects would be similar to those under the Proposed Project and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, as with the Proposed Project, areas adjacent to the cold-water springs in the Bypass Reach would continue to serve as thermal refugia for aquatic species because the springs themselves would not be affected by the Continued Operations with Fish Passage Alternative. If volitional fishways were implemented (rather than trap and haul; as described below in Section 4.4.3.7 *Fish Passage*) anadromous fish would be able to move through the Hydroelectric Reach and might be seasonally exposed to high temperatures during upstream and downstream migration. Water temperature in Copco No. 1 and Iron Gate reservoirs can be high from June to September (Section 3.2.2.2 *Water Temperature*) and surface layers may seasonally exceed thermal tolerances for salmonids or resident fish. During late spring through summer, early fall-run Chinook salmon adult migrants could be exposed to high water temperatures, as well as spring-run Chinook salmon adults not already holding in tributary habitat; for spring-run Chinook salmon, peak migration would occur outside of the period of high water temperatures, and most juvenile outmigration occurs earlier in the spring or later in the fall. However, fall-run Chinook salmon migrating upstream through Iron Gate Reservoir and Copco No. 1 Reservoir during the primary period of their migration (August and September) would be limited to waters exhibiting suitable dissolved oxygen concentrations; under existing conditions, these concentrations are located within the top approximately 10 meters of depth in these two reservoirs where water temperatures are greater than approximately 23ºC in most years (see Appendix C – *Section C.1* and *C.4*.) The combination of warm water temperatures in surface waters and low dissolved oxygen below approximately 10 meters would potentially limit upstream migration of a proportion of fall-run Chinook salmon through the Hydroelectric Reach, unless migrating fish are able to remain within a water depth shallow enough to provide suitable dissolved oxygen and deep enough to avoid unsuitable water temperatures. If the trap and haul fish passage option was implemented consistent with FERC (2007), these water quality migration impediments would be avoided (as described in Section 4.4.3.7 *Fish Passage*).

Since J.C. Boyle Reservoir, with its large thermal mass, would remain in place under the Continued Operations with Fish Passage Alternative, effects on diel temperature variation in the Bypass Reach would be similar to those described for existing conditions (i.e., reduced diel temperature variation). Maximum water temperatures in the Peaking Reach would be slightly cooler and temperatures would be less artificially variable compared to existing conditions due to higher overall flows and the lower frequency of peaking operations at the J.C. Boyle Powerhouse.

Under existing conditions, there is a delay in the normal progression of water temperatures downstream from Iron Gate Dam (or Phase Shift from historical timing) (Bartholow et al. 2005). Under this alternative, the current phase shift and lack of temporal temperature diversity would persist, including current warm temperatures in late summer and fall (Hamilton et al. 2011). Juveniles and adults migrating later in the year would continue to experience warm temperatures in late summer and fall that could be deleterious to health and survival, including increased risk of disease, and high rates of delayed spawning and pre-spawn mortality (Hetrick et al. 2009). As there is currently no reasonable proposal to achieve the temperature allocations in the Klamath River TMDLs with the Lower Klamath Project dams remaining in place, and long-term climate change-induced increases in water temperatures would partially offset any TMDL improvements (see Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1), overall the Continued Operations with Fish Passage Alternative would maintain existing adverse late summer/fall water temperatures in the reach downstream from Iron Gate Dam.

4.4.3.4 Fish Disease and Parasites

As discussed in detail in Section 3.3.2.3, *Habitat Attributes Expected to be Affected by the Proposed Project [Fish Disease and Parasites],* under the existing condition, fish diseases, specifically the myxozoan parasites *Ceratomyxa shasta* (*C. shasta*) and *Parvicapsula minibicornis (P. minibicornis),* regularly result in substantial mortality of Klamath River salmon (Fujiwara et al. 2011, True et al. 2013). Additional diseases that may affect fish in the Klamath Basin include *Ichthyophthirius multifis* (Ich) and *Flavobacterium columnare* (columnaris). These parasites and diseases occur throughout the watershed but appear to cause the most severe mortality in the Lower Klamath Basin where *C. shasta* has been observed to result in high rates of mortality in salmon (True et al. 2013). Ich and columnaris occasionally result in substantial mortality (e.g., the 2002 fish kill of primarily adult Chinook salmon)

As discussed in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Fish Disease and Parasites],* there is currently an infection nidus (reach with the highest disease infection) for *C. shasta* and *P. minibicornis* in the Klamath River in the reach from the Shasta River downstream to Seiad Valley. With fish passage, there would be the potential that in addition to the current infection nidus downstream of Iron Gate Dam, an additional nidus could be created in upstream areas where salmon spawning congregations occur (Foott et al. 2012). Any creation of a new infection zone upstream, or the continuation of the existing infection zone (or zones) would be the result of the synergistic effect of numerous factors, such as those that occur within the current disease zone (FERC 2007, Bartholomew and Foott 2010).

Under the Continued Operations Alternative with Fish Passage Alternative, some of these conditions would persist relatively unchanged, while others would be reduced. The conditions promoting infection zones which would continue to occur under this alternative include an altered hydrograph and altered sediment transport rates below Iron Gate Dam (Hetrick et al. 2009). Additionally, altered water temperatures driven by Lower Klamath Project reservoirs would continue.

However, this alternative also has the potential to reduce crowding downstream of Iron Gate Dam, through the provision of upstream fish passage. FERC's (2007) analysis concluded that restoring access to reaches above Iron Gate Dam for anadromous fish would allow adult fall-run Chinook salmon to distribute over a greater length of the river, reducing crowding and the concentration of disease pathogens that currently occur in the reach between Iron Gate Dam and the Shasta River. This would be a reduction in conditions that promote infection zones. However, provision of fish passage alone will not eliminate crowding at Iron Gate Dam or some of the conditions to contribute to high infection rates. Concentrations of myxospore-infected salmon carcasses downstream from Iron Gate Dam are likely to still be elevated in association with two factors. First, the continued operation of Iron Gate Hatchery will continue to promote congregations of adult salmonids near the base of Iron Gate Dam. Second, congregations of adults at the entrance to fish passage facilities are likely to occur. Thus, crowding would be ameliorated, but not eliminated as a contributing factor to high disease rates.

Additionally, as described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, in 2017, the United States District Court ordered USBR to change operations to meet court-ordered flushing and dilution flows below Iron Gate Dam. These are not modeled as part of existing conditions hydrology. These flows are aimed at reducing fish disease downstream of Iron Gate Dam. This alternative assumes that these flows would continue to be required, because the addition of habitat alone is unlikely to eliminatethe current nidus downstream of Iron Gate Dam under the Continued Operations with Fish Passage Alternative.

Therefore, under this alternative, fish disease would potentially be reduced by the addition of habitat and associated reduction in crowding below Iron Gate Dam, and the continued operation of 2017 flow requirements. The flow and dilution requirements alone have not been successful in eliminating the disease nidus. Although the conditions leading to nidus downstream of Iron Gate Dam will be ameliorated by reduced crowding, and by flushing and dilution flows as required by the 2017 court order, the nidus is anticipated to continue to occur to some degree.

As discussed in detail for the Proposed Project in Section 3.3.5.5 *Fish Disease and Parasites*, available information indicates that fish passage under the Continued Operations with Fish Passage Alternative would not increase the risk of disease for resident species that occur upstream of Iron Gate Dam (NMFS 2006a).

4.4.3.5 Algal Toxins

Upper Klamath River—Hydroelectric Reach

Continued impoundment of water in the Lower Klamath Project reservoirs under the Continued Operations with Fish Passage Alternative would continue to support growth conditions for toxin-producing nuisance algal species such as *Microcystis aeruginosa* in Copco No. 1 and Iron Gate reservoirs, resulting in high seasonal concentrations of algal toxins in the Hydroelectric Reach and downstream for decades into the future. As described for existing conditions in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Algal Toxins]*, this would result in continued bioaccumulation of microcystin in fish tissue for species in the Hydroelectric Reach and could be deleterious to fish health. As there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months with the Lower Klamath Project dams remaining in place (see Potential Impact

4.2.2-7), overall the Continued Operations with Fish Passage Alternative would maintain existing adverse high seasonal concentrations of algal toxins in the Hydroelectric Reach. For salmonids, impacts would be similar to those currently observed downstream from Iron Gate Dam.

Middle and Lower Klamath River

Continued impoundment of water in the Lower Klamath Project reservoirs under the Continued Operations with Fish Passage Alternative would continue to support the seasonal transport of toxin-producing nuisance algae and microcystin to the Klamath River downstream from Iron Gate Dam. This would result in continued bioaccumulation of microcystin in muscle tissue for aquatic species in the river and could be deleterious to fish health. As there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations transported to the Klamath River downstream from Iron Gate Dam during summer and fall months (see Potential Impact 4.2.2-7), overall the Continued Operations with Fish Passage Alternative would maintain existing adverse high seasonal concentrations of algal toxins in the Klamath River downstream of Iron Gate Dam. For aquatic species, impacts would be similar to those currently observed downstream from Iron Gate Dam (described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Algal Toxins]*).

4.4.3.6 Aquatic Habitat and Instream Flows

Under the Continued Operations with Fish Passage Alternative, access to historical anadromous fish habitat would be restored to some degree. Volitional fishways would provide anadromous fish access to 58 miles of habitat upstream of Iron Gate Dam not inundated by Lower Klamath Project reservoirs (and downstream of Keno Dam) (DOI 2007). This is considered historical habitat for coho salmon, Pacific lamprey, fall-run Chinook salmon, spring-run Chinook salmon, and steelhead (Hamilton et al. 2005, 2016). Volitional fishways would also provide 360 miles of habitat upstream of Upper Klamath Lake and Keno Impoundment/Lake Ewauna (Huntington 2006, DOI 2007, NMFS 2007). This is considered historical habitat for fall-run Chinook salmon, spring-run Chinook salmon, and steelhead (Hamilton et al. 2005, 2016). The number of miles of fish habitat made potentially available under this alternative may also be impaired by high water temperatures in during some seasons in association with Lower Klamath Project reservoirs, as described above in *Water Quality*.

If fish passage were provided by trap and haul (as described below), the amount of habitat upstream of Upper Klamath Lake and Keno Impoundment/Lake Ewauna would be the same, but of the 58 miles of habitat between Iron Gate Dam and Keno Dam, only approximately 25 miles of habitat would be available on the mainstem Klamath River between J.C. Boyle and Keno, and within Spencer Creek (Huntington 2006, FERC 2007).

Hydrology of the Klamath River from Iron Gate Dam to the Klamath River Estuary would generally remain the same as under existing conditions. Additional winter-spring surface flushing flows and deep flushing flow requirements outlined in *Measures to Reduce Ceratanova Shasta Infection of Klamath River Salmonids: A Guidance Document* and U.S. District Court Filing 111 (U.S. District Court 2017a–c; see also Section 4.4.1

[Continued Operations with Fish Passage Alternative] Introduction – Alternative Description) is predicted to help reduce juvenile salmon disease below Iron Gate Dam, as discussed in Section 4.4.3.4 *Fish Disease and Parasites*. However, as described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing and dilution flows required to be released from Iron Gate Dam are not modeled as part of existing conditions hydrology.

Activities currently underway to recover salmonid and sucker populations within the Klamath Basin would likely continue at their current levels. See Section 5, *Cumulative Impacts* for information on salmonid and sucker recovery activities.

Under this alternative, there would be substantial changes to hydroelectric operations. J.C. Boyle Powerhouse would no longer generate in peaking mode, and higher flow releases would be made through the J.C. Boyle Bypass Reach than under existing conditions. Higher base flows would also be provided in the Copco No. 2 Bypass Reach. Peaking operations would only occur one day a week to coincide with recreation flows, at least 40 percent of flow would go into the Bypass Reach (and not enter the powerhouse), and ramping rates would be slower than they are currently. Seasonal high flows would contribute to improving the quality of riparian habitat in the J.C. Boyle Bypass Reach by increasing the sediment deposited within the channel and decreasing reed canary grass (NMFS 2006a). The more normative flow regime associated with this alternative would provide these seasonal high flows. These modifications would benefit fish in this reach, including redband trout and anadromous fish.

As discussed in Section 4.2.3.2, Potential Impact 4.2.3-21, continued implementation of the Coho Enhancement Fund under the Continued Operations with Fish Passage Alternative would continue to provide benefits to fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, freshwater mussels, and benthic macroinvertebrates. These actions are also beneficial for coho salmon (particularly from the Upper Klamath River Population Unit). Implementation of the Coho Enhancement Fund under the No Project Alternative would have no significant impact (no change from existing conditions) on redband trout, shortnose and Lost River suckers, green sturgeon, eulachon, and Southern Resident Killer Whales, since these species are not found in or near the river reaches associated with IM2 projects or actions.

4.4.3.7 Fish Passage

Under the Continued Operations with Fish Passage Alternative, fish migrating upstream and downstream past Lower Klamath Project dams and reservoirs would have fishways for the provision of safe and timely passage, consistent with FERC (2007). Under the Continued Operations with Fish Passage Alternative upstream and downstream fish passage at all four Lower Klamath Project dams would be provided consistent with the prescriptions from the U.S. Department of Interior (DOI) and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007), and in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*, including barriers to prevent juvenile salmonid entrainment into turbines. This alternative assumes fish passage is consistent with the general prescriptions (DOI 2007) that cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007). As noted, this alternative also provides information on where trap and haul would result in different impacts, although that process would not comply with the mandatory conditions.

Fish migrating through fishways may experience delay, injury, and mortality, beyond what would occur from natural migration in the absence of dams and reservoirs (FERC 2007). In the relicensing proceeding for the Klamath Hydroelectric Project, NMFS (2006) recommended dam removal as the preferred alternative to provide the least mortality and injury to migrating fish. NMFS' mandatory fishway prescription (DOI 2007) was submitted in the event that FERC chose to reject NMFS' recommendation to removal all Lower Klamath Project mainstem dams. In the FERC (2007) analysis, potential mortality occurring during fish passage was considered for fall-run Chinook salmon adults and juveniles, for both volitional fishways (e.g., fish ladders and screened turbines), as well as for trap and haul. In analyzing volitional fishways FERC (2007) considered potential sources of mortality for upstream and downstream migrating fish, such as poor water quality conditions, predatory fish in Lower Klamath Project reservoirs, and injuries while passing through multiple fish ladder and screening facilities. As described in Section 4.4.3.3 *Water Quality*, poor water quality conditions in Iron Gate and Copco No. 1 reservoirs would likely limit migration of a proportion of the adult fall-run Chinook salmon migration through the Hydroelectric Reach during most years if fish passage were provided from volitional fishways at each of the Lower Klamath Project facilities, unless migrating fish are able to remain within a water depth shallow enough to provide suitable dissolved oxygen and deep enough to avoid unsuitable water temperatures.

Based on the reservoir dynamics and the predator population that currently occurs, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (NMFS 2006a). In restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (NMFS 2006a). These potential sources of mortality were estimated based on Oosterhout (2005, cited from PacifiCorp 2006). FERC (2007) predicted that average cumulative (migration in reservoirs and through fishways) mortality for adult Chinook salmon migrating upstream from Iron Gate Dam to upstream of J.C. Boyle Dam would be 28 percent with volitional fish ladders. The prediction for juveniles migrating downstream from Upper Klamath Lake to downstream of Iron Gate was 58 percent mortality for passage through the reservoirs and volitional fishways. For this analysis, it is assumed that effects of passage through volitional fishways would be equivalent for other migratory species, which appears to be a reasonable assumption based on available data (DWR 2013) for fishways designed and constructed to modern agency criteria as required by DOI (2007).

Trap and haul fish passage facilities are described by FERC (2007) and are addressed under the Continued Operations with Fish Passage Alternative to the extent the impacts of trap and haul would be different from those considered under mandatory fishway conditions. However, trap and haul facilities do not provide volitional fish passage, and thus are not considered by NMFS or USFWS to be equivalent to volitional fishways, such as fish ladders and downstream bypass facilities. The trap and haul alternative described by FERC (2007), would consist of trapping upstream adult migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Iron Gate Dam (potentially far enough downstream to avoid disease issues). In addition, the trap and haul option avoids water quality impediments to upstream migration for adult fall-run Chinook salmon described in Section 4.4.3.3 *Water Quality*. Therefore, trap and haul was predicted to have lower cumulative mortality than volitional ladders, since this option would avoid mortality associated with passage through the Lower Klamath Project reservoirs and riverine habitat that would be bypassed. FERC (2007) predicted that average cumulative mortality for adult Chinook salmon migrating upstream from Iron Gate Dam to upstream of J.C. Boyle Dam would be 21 percent for trap and haul. The prediction for juveniles migrating downstream from Upper Klamath Lake to downstream of Iron Gate was 46 percent for trap and haul. However, the FERC analysis did not consider the impacts of the trap and haul operation itself, such as handling and trucking stress and mortality. The recent review of Lusardi and Moyle (2017) note that adults trapped and hauled upstream experience high (> 20 percent) pre-spawn mortality rates, and juvenile salmonids transported downstream are observed to experience delayed mortality, reduced growth rates, and increased predation. Therefore, for purposes of comparing the impacts of the Continued Operations with Fish Passage alternative with the impacts of trap and haul, this analysis does not assume that mortality would be different from that estimated for volitional fishways reported by FERC (2007). In addition, for this analysis, it is assumed that effects of passage through trap and haul facilities would be equivalent for other migratory species, which is a reasonable assumption for modern fishways designed to accommodate all species (including Pacific lamprey).

Potential Impact 4.2.3-1 Effects on coho salmon critical habitat quality and quantity due to continued operations of the Lower Klamath Project.

Under the Continued Operations with Fish Passage Alternative, coho salmon would be able to access habitat in the Hydroelectric Reach by ascending the fishways associated with each of the dams. Available habitat for coho salmon would be approximately 54 miles with volitional fishways. If trap and haul were implemented to actively transport coho salmon migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 54 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[197], reduced in some part for the propensity of coho salmon to remain in lower gradient habitat than steelhead (DOI 2007), habitat in the bypass reaches, and the continued inundation of approximately 22 miles of spawning and rearing habitat by the Lower Klamath Project reservoirs (Cunanan 2009). The upstream boundary of critical habitat for coho salmon in the Klamath Basin is Iron Gate Dam; any newly accessible areas would be outside of their currently designated critical habitat. NMFS may want to consider including the newly accessible reaches as critical habitat as part of their 5-year status review or in a separate decision (J. Simondet, NOAA Fisheries Service, pers. comm., 2011). The areas inundated by the reservoirs would not provide suitable spawning or rearing habitat for coho salmon, but coho salmon would regain access to the riverine reaches on the mainstem and to the tributaries, although the downstream ends of most of the tributaries would remain inundated by the reservoirs. It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*.

[197] This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through elimination of peaking operation flows and increased base flows.

Water temperatures would continue to be seasonally affected by the reservoirs. Similar to existing conditions, temperatures would be warmer in the summer and fall when adults are migrating upstream and may pose a degree of seasonal risk to adult that are located downstream from Iron Gate Dam, migrating within reservoirs or in bypass reaches. As under existing conditions, this thermal stress may continue to contribute to coho salmon being more susceptible to disease downstream of Iron Gate Dam. Relative to existing conditions, the slight decreases in long-term maximum summer/fall water temperatures and less artificial diel temperature variation in the J.C. Boyle Peaking Reach would return the river to a more natural thermal regime (see also Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1).

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease in salmon under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

In terms of Primary Constituent Elements (PCEs) of coho salmon critical habitat, this alternative would provide access to additional spawning habitat upstream of currently designated critical habitat, including in Fall, Jenny, Shovel, and Spencer creeks, although the downstream ends of these streams would continue to be inundated by the reservoirs and would not provide suitable spawning or rearing habitat. Delay, injury, and mortality could occur for upstream migrating adults, and downstream migrating juveniles. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be approximately 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrating juveniles; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality.

The food resources in these tributaries would also become available to fry and juvenile coho salmon rearing in those streams. Despite the modest water quality improvements achieved to date through implementation of actions contained within PacifiCorp’s Reservoir Management Plan (see also Section 4.4.2 *Water Quality*), there is currently no reasonable proposal to achieve water quality standards important to coho salmon within or downstream of the Hydroelectric Reach. Based on the current designation of critical habitat, the effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for coho salmon critical habitat in the short term and long term.

Significance

No significant impact to coho salmon critical habitat in the short term and long term

Potential Impact 4.2.3-2 Effects on Southern Resident Killer Whale critical habitat quality due to alterations to salmon populations due to continued operations of the Lower Klamath Project.

Klamath River contributes to critical habitat for Southern Resident Killer Whales through its contribution of salmon to their food supply (included as a PCE). The Continued Operations with Fish Passage Alternative would not affect the geographic extent of critical habitat for this species, as it is located in the state of Washington. Implementation of this alternative is expected to increase production of salmon (as described in Potential Impacts 4.2.3-7, 4.2.3-8, and 4.2.3-9), which could increase food supply for Southern Resident Killer Whales. However, data on the Southern Resident Killer Whale diet indicate that based on the migratory range and behavior of the population, the Klamath River salmon are anticipated to provide less than one percent of the diet of Southern Resident Killer Whales in most months under current and future conditions. While Southern Resident Killer Whales have been shown to consume Klamath River Chinook salmon, the Klamath River is considered by NMFS and Washington Department of Fish and Wildlife (WDFW) tenth out of the top ten priority Chinook salmon populations for Southern Resident Killer Whales (NMFS 2018b, NMFS and WDFW 2018). Under this alternative, Iron Gate Hatchery would continue to operate and target existing production levels of hatchery Chinook salmon and contribution to ocean stocks. Due to the low proportion of the Sothern Resident Killer Whale diet being composed of Klamath River salmon, the Continued Operations with Fish Passage Alternative would result in no significant impact in the short term and long term.

<u>Significance</u>

No significant impact to Southern Resident Killer Whale critical habitat in the short term and long term

Potential Impact 4.2.3-3 Effects on eulachon critical habitat quality due to continued operations of the Lower Klamath Project.

Implementation of the Continued Operations with Fish Passage Alternative would not affect eulachon critical habitat. The Continued Operations with Fish Passage Alternative would not cause an alteration to habitat conditions in the Klamath River Estuary and Pacific Ocean nearshore environment compared to the existing conditions.

<u>Significance</u>

No significant impact to eulachon critical habitat in the short term and long term

Potential Impact 4.2.3-4 Effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.

Implementation of the Continued Operations with Fish Passage Alternative would increase habitat for Chinook and coho salmon (upstream of currently designated EFH) by providing access to habitat upstream of Iron Gate Dam. As described above for Potential Impact 4.2.3-1, water quality, sediment dynamics, and fish disease affecting EFH would not change substantially from the existing conditions detailed in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*. Under this alternative, designated EFH for Chinook and coho salmon would be expected to remain similar to its current condition, as described for existing conditions (Section 3.3.2.1 *Aquatic Species*). The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for Chinook and coho salmon designated EFH in the short term and long term.

Significance
No significant impact for Chinook and coho salmon EFH in the short term and long term

Potential Impact 4.2.3-5 Effects on groundfish Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.
Implementation of the Continued Operations with Fish Passage Alternative would not affect groundfish EFH. Habitat conditions within the estuary and nearshore environment would not be altered as result of this alternative. The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for groundfish EFH in the short term and long term.

Significance
No significant impact to groundfish EFH in the short term and long term

Potential Impact 4.2.3-6 Effects on pelagic fish Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.
Implementation of the Continued Operations with Fish Passage Alternative would not affect pelagic fish EFH. Habitat conditions within the estuary and nearshore environment would not be altered as result of this alternative. The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for pelagic fish EFH in the short term and long term.

Significance
No significant impact to pelagic fish EFH in the short term and long term

Potential Impact 4.2.3-7 Effects on the fall-run Chinook salmon population due to continued operations of the Lower Klamath Project.
Upper Klamath River and Connected Waterbodies
Under the Continued Operations with Fish Passage Alternative, fish passage facilities installed at the Lower Klamath Project dams within the Hydroelectric Reach would allow fall-run Chinook salmon to regain access to 360 miles of habitat upstream of J.C. Boyle Reservoir. The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005, Hamilton et al. 2016). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive habitat (DOI 2007), including access to groundwater discharge areas relatively resistant to effects of climate change (Hamilton et al. 2011).

Water quality problems (e.g., excessive water temperatures and low dissolved oxygen) that currently occur in the Keno Impoundment/Lake Ewauna during late spring, summer, and early autumn, may challenge fall-run Chinook salmon accessing these areas under the Continued Operations with Fish Passage Alternative. As discussed under Section 3.3.5.3 *Water Quality*, the Keno Impoundment/Lake Ewuana has the potential to be a habitat barrier during most years for fall-run Chinook due to poor water quality during the late summer, and therefore NMFS and USFWS have prescribed fish passage measures for the Keno Impoundment/Lake Ewuana to be used during periods of poor water quality (DOI 2007). If fish passage were not provided, fall-run Chinook salmon would be limited to the additional habitat access in the Hydroelectric Reach, as described in detail below. While seasonal dissolved oxygen in the Keno Impoundment/Lake Ewauna would be expected to improve in furtherance of TMDL implementation throughout the Upper

Klamath Basin, it would be speculative at this point to identify either the mechanisms necessary to fully implement the TMDLs or the timing required to achieve full compliance, thus this EIR assumes that trap and haul around the Keno Impoundment/Lake Ewauna would be needed in years of poor water quality for fish to be able to access habitat upstream of Keno Dam.

Implementation of the Continued Operations with Fish Passage Alternative would result in no change from existing conditions for suspended sediments or bedload sediment, flow-related habitat, or algal toxins and disease in this reach.

Upper Klamath River – Hydroelectric Reach

Implementation of the Continued Operations with Fish Passage Alternative would restore fall-run Chinook salmon access to the Hydroelectric Reach by providing fishways associated with each of the Lower Klamath Project dams. Available habitat for fall-run Chinook salmon would be approximately 54 miles with volitional fishways. However, low DO and high-water temperatures in Iron Gate and Copco No. 1 reservoirs would likely limit upstream migration of fall-run Chinook salmon during the peak of their migration (as described in Section 4.4.3.3 *Water Quality*), potentially limiting their access to habitat upstream of Iron Gate Dam, unless migrating fish are able to remain within a water depth shallow enough to provide suitable dissolved oxygen and deep enough to avoid unsuitable water temperatures. If trap and haul were implemented to actively transport fall-run Chinook salmon migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 54 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[198], reduced in some part for the propensity of fall-run Chinook salmon to remain in lower gradient habitat than steelhead (DOI 2007), habitat in the bypass reaches, and the continued inundation of approximately 22 miles of spawning and rearing habitat by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated juveniles would migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be approximately 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality in the reach.

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through elimination of peaking operation flows and increased base flows. Under this alternative, the expected overall higher flow releases would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Project and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, fishways would provide access to thermal refugia created by 200 to 250 cfs of spring flow accretion in the J.C.

198 This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

Boyle Bypass Reach (DOI 2007, FERC 2007). Under this alternative, suspended and bedload sediment, water quality, and algal toxins would be the same as under existing conditions.

Under this alternative fish migrating through reservoirs would be seasonally exposed to some degree to stressful water quality conditions including high temperatures in reservoir surface layers with low dissolved oxygen in reservoir surface layers in the summer and fall, changes in dissolved oxygen, pH, and ammonia associated with algal blooms, and exposure to microcystin from *Microcystis aeruginosa* blooms (Dunsmoor and Huntington 2006, FERC 2007). These conditions can become stressful in June through September, contributing to lower resistance to disease seasonally. Based on the reservoir dynamics and the predator population that currently occurs therein, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (NMFS 2006a). In restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (NMFS 2006a).

The amount of time required for the fall-run Chinook salmon population to reach capacity under this alternative would be a function of adult returns that recolonize new habitat. Recolonization success and rate is a function of fish straying into newly available habitats (Pess 2009). For Chinook salmon, stray rates are approximately six percent (Hendry et al. 2004), and 95 percent of strays migrate less than 20 miles from their natal area (Quinn and Fresh 1984, Quinn et al. 1991). However, following major changes in environmental conditions (e.g., dam removal, high SSC), salmonid stray rates have been observed to increase above these average levels. The time period of colonization (historical or new habitat) has been reported to occur within five to thirty years, with most falling between one to two decades (Withler 1982, Bryant 1999, Burger et al 2000, Glen 2002, Pess et al. 2003, Milner et al. 2008, Kiffney et al. 2009). Rapid (less than one year) recolonization was observed for fall-run Chinook salmon following fish ladder installation at Landsburg Dam on the Cedar River, Washington (Kiffney et al. 2009). A ladder was placed on the Landsburg Dam in 2003, and Chinook salmon immediately (i.e., the first fall following ladder installation) accessed areas upstream of the dam, with juveniles being observed during snorkel surveys the following year. By 2011, Chinook salmon occurred throughout nearly all accessible habitat upstream of the dam. It is likely that under this alternative fall-run Chinook salmon would recolonize newly accessible habitat.

Middle and Lower Klamath River

Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a). Coarsening of the bed could reduce spawning habitat for fall-run Chinook salmon downstream from the dam over time, but this impact would be limited to the area upstream of Cottonwood Creek. Rearing habitat would be expected to remain similar to existing conditions.

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath River downstream from Iron Gate Dam reach would continue to have seasonally poor water quality because of the continued presence of the reservoirs with their increased hydraulic residence time and thermal mass (Section 3.2.2.2 *Water Temperature*). The continuation of warm water releases from Iron Gate Dam would contribute to delay adult upstream migration of fall-run Chinook salmon (Dunsmoor and Huntington 2006) and increase the risk of mortality prior to spawning (Hamilton et al. 2011). PacifiCorp's Reservoir Management Plan actions, such as further development and use of an intake barrier/thermal curtain, may slightly reduce water temperatures downstream of Iron Gate Dam, but recent data indicate that only modest 1–2°C (1.8–3.6°F) water temperature improvement is possible using this approach (PacifiCorp 2017). Further, the maximum useable cool water volume in Copco No. 1 Reservoir in summer and the maximum volume of cold water (8°C or less) in Iron Gate Reservoir in summer are limited, such that selective withdrawal from the reservoirs would be anticipated to decrease water temperatures immediately downstream of Iron Gate Dam by only 1 to 2°C in late summer/early fall. PacifiCorp has also noted that the water supply for Iron Gate Hatchery withdraws cold water from the deeper portion of Iron Gate Reservoir, and depleting or exhausting this cold water pool during the summer would have effects on the hatchery that would need to be addressed (PacifiCorp 2014) (see also discussion under Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1).

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease in salmon under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Ocean Nearshore Environment

Habitat conditions within the estuary and nearshore environment would not be altered as result of this alternative. The Continued Operations with Fish Passage Alternative is not expected to substantially alter fall-run Chinook salmon estuarine habitat.

Summary

In the short term, there would be no impact (no change relative to existing conditions) for fall-run Chinook salmon populations from the habitat attributes that would be anticipated to affect the population within a short (i.e., less than five years) time frame.

In the long term (i.e., more than five years*)*, under this alternative, fish passage would result in alterations in habitat availability for fall-run Chinook salmon. However, low DO and high-water temperatures in Iron Gate and Copco No. 1 reservoirs would likely limit upstream migration of fall-run Chinook salmon during the peak of their migration (as described in Section 4.4.3.3 *Water Quality*), potentially limiting their access to habitat upstream of Iron Gate Dam if fish passage was provided by volitional fishways rather than trap and haul, unless migrating fish are able to remain within a water depth shallow enough to provide suitable dissolved oxygen and deep enough to avoid unsuitable water temperatures. In addition, if fish passage is not provided a Keno Impoundment/Lake Ewuana, restored habitat access to the Hydroelectric Reach would be beneficial for fall-run Chinook salmon in the long term. If fish passage were provided at Keno (per DOI [2007] fish passage prescriptions), an even greater magnitude of restored habitat access to the Upper Klamath River Basin. Mortality could occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs.

This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on fall-run Chinook salmon populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-7). The overall effect of the Continued Operations with Fish Passage Alternative on fish disease may be slightly improved but is unlikely to be substantially altered from existing conditions.

It is anticipated that increased habitat availability as a result of the Continued Operations with Fish Passage Alternative the fall-run Chinook salmon population within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity if fish passage were to be provided by trap and haul rather than volitional fishways. Out-migrating smolts would continue to be subject to deleterious effects downstream from Iron Gate Dam. While the degree of harm may be reduced, the types of effects would be continued as under the existing condition. If fish passage were provided that avoided water quality barriers to adult upstream migration (i.e., trap and haul), increases in abundance, population spatial structure, and genetic diversity would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall increases in the viability for fall-run Chinook salmon in the long term.

<u>Significance</u>

No significant impact for fall-run Chinook salmon in the short term

Beneficial for fall-run Chinook salmon in the long term

Potential Impact 4.2.3-8 Effects on the spring-run Chinook salmon population due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Under the Continued Operations with Fish Passage Alternative, fish passage facilities installed at the Lower Klamath Project dams within the Hydroelectric Reach would allow spring-run Chinook salmon to regain access to 360 miles of habitat in the upper Klamath River upstream of J.C. Boyle Reservoir. The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005, Butler et al. 2010, Hamilton et al. 2016). Huntington (2006) reasoned that spring-run Chinook salmon likely accounted for the majority of the Upper Klamath Basin's actual salmon production under historical conditions. Overall, the Continued Operations with Fish Passage Alternative would provide spring-run Chinook access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive anadromous fish habitat upstream of Iron Gate Dam (DOI 2007), including access to important thermal refugia within areas influenced by groundwater exchange that are more resistant to climate change (Hamilton et al. 2011). Some of these areas, such as the lower Williamson River, have habitat that would provide substantial holding areas for spring-run Chinook salmon (Hamilton et al. 2011). Other holding areas with suitable temperatures upstream of J.C. Boyle Reservoir include groundwater influenced areas on the west side of Upper Klamath Lake, and the Wood River (Gannett et al. 2007).

Poor water quality (e.g., severe hypoxia, temperatures exceeding 77°F, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009, USGS 2010; both as cited in Hamilton et al. 2011). However, available information indicates that Upper Klamath Lake habitat is presently suitable to support Chinook salmon for at least the period from October through May (Maule et al. 2009). Currently, adult spring-run Chinook migration takes place in approximately April through June. Historically, adult spring-run Chinook salmon migrated upstream of the current location of Iron Gate Dam perhaps as early as February and March (Fortune et al. 1966) and likely held over in large holding pools in the mainstem in tributaries fed by cool water, and in thermal refuge habitat upstream of Upper Klamath Lake (Snyder 1931, CDFG 1990c, Moyle 2002). One benefit of such early migration (similar to the spring-run Chinook salmon migration timing currently observed in the Klamath Basin) would be the avoidance of periods of poor water quality in the vicinity of Keno Impoundment/Lake Ewuana. Under the current migration timing, most or all of the spring-run Chinook salmon migrants would be able to pass upstream through the Keno Impoundment/Lake Ewuana area before seasonal water quality reductions would make passage restricted.

Upper Klamath River – Hydroelectric Reach

Implementation of the Continued Operations with Fish Passage Alternative would restore spring-run Chinook salmon access to the Hydroelectric Reach by providing fishways associated with each of the Lower Klamath Project dams. Available habitat for spring-run Chinook salmon would be approximately 54 miles with volitional fishways. (If trap and haul were implemented to actively transport spring-run Chinook salmon migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat.) The estimate of 54 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[199], reduced in some part for the propensity of spring-run Chinook salmon to remain in lower gradient habitat than steelhead (DOI 2007), habitat in the bypass reaches, and the continuation of approximately 22 miles of spawning and rearing habitat inundated by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be approximately 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007). As mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrating juveniles; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality.

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows. Under this alternative, the expected overall higher flow releases than under current conditions would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Project and would move this short reach away from the existing condition of consistently cooler water temperatures during summer and early fall months; however, passage structures would provide fish with some refuge from high temperatures due to access to cooler water from tributaries, in addition to that provided by 200 to 250 cfs of accretion from springs in the J.C. Boyle Bypass Reach (DOI 2007, FERC 2007, Hamilton et al. 2011). With the construction of fish passage facilities, flows and access would also be restored to the 1.4-mile Copco No. 2 Bypass Reach. Under this alternative, suspended and bedload sediment, water quality, and the occurrence of fish disease and algal toxins would be the same as under existing conditions.

This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist within reservoirs. Adult spring-run Chinook salmon in the Klamath River migrate upstream from April through June (and possibly earlier, Fortune et al. 1966), and most juveniles migrate from April through May or in the fall, as flows increase. Therefore, poor water quality in reservoirs is expected to have minor effects on this species, and only at the early and late ends of migration periods, outside peak migration times.

199 This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

There are a few basic mechanisms by which spring-run Chinook salmon could recolonize newly accessible habitat, including: (1) straying of adults, (2) adaptation of fall-run Chinook salmon to an early spring-run Chinook salmon life history, or (3) active reintroduction of spring-run Chinook salmon from another population. There are many examples of spring-run Chinook salmon rapidly recolonizing newly accessible habitat discussed in Potential Impact 4.2.3-7 above, and spring-run Chinook salmon were observed recolonizing habitat in the White Salmon River, Washington, following removal of Condit Dam (Allen et al. 2016). Following the removal of Condit Dam most of the observed spring-run Chinook salmon spawning was upstream of the location of the former Condit Dam. The current spring-run Chinook salmon abundance in the Salmon River is low (Table 3.3-10), and the rate of recolonization could be slow as a result.

The potential for adaptation of fall-run Chinook salmon to a spring-run Chinook salmon life history was assessed by Thompson et al. (2018), and they concluded that based on the genetics of the fall-run Chinook salmon currently downstream of Iron Gate Dam, it was unlikely that this would occur. Active reintroduction of Chinook salmon with genetics suited to adapt to an early spring-run Chinook salmon life history may be successful strategy for recolonization (Thompson et al. 2018). The Continued Operations with Fish Passage Alternative does not include an active reintroduction plan, although ODFW has been considering implementing active reintroduction of spring-run Chinook salmon following dam removal (T. Wise, ODFW, pers. comm., 2018). Such a strategy could be considered under this alternative as well.

Middle and Lower Klamath River

Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate Dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a).

Under the Continued Operations with Fish Passage Alternative, the Klamath River downstream from Iron Gate Dam would continue to have seasonally poor water quality related to temperature because of the continued presence of the reservoirs, with their increased hydraulic residence time and thermal mass (Section 3.2.2.2 *Water Temperature*). There is currently no reasonable proposal to achieve the temperature allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place, despite the modest improvements achieved to date through implementation of actions contained within PacifiCorp's Reservoir Management Plan (see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1). Under this alternative, the current phase shift and lack of temporal temperature diversity will persist, including current warm temperatures in late summer and fall (Hamilton et al. 2011). Juveniles and adult migrants would continue to experience warm temperatures in late summer and fall that could be deleterious to health and survival, including increased risk of disease, and high rates of delayed spawning and pre-spawn mortality (Hetrick et al. 2009). These effects would be most pronounced for fish migrating through areas upstream of the Scott River, because tributary contributions dampen the temperature effect of the dams further downstream, as discussed in Section 3.2.2.2 *Water Temperature*.

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease for spring-run Chinook salmon migrating from newly accessible habitat upstream of Iron Gate Dam under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Ocean Nearshore Environment

The Continued Operations with Fish Passage Alternative is not expected to substantially alter spring-run Chinook salmon estuarine habitat.

Summary

In the short term, there would be no impact (no change relative to existing conditions) for spring-run Chinook salmon from the habitat attributes that would be anticipated to affect the population within a short (less than five years) time frame.

In the long term (more than five years), under this alternative, fishways could result in alterations in habitat availability for spring-run Chinook salmon. Under the Continued Operations with Fish Passage Alternative, spring-run Chinook salmon could regain access to approximately 414 miles of mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach, which would benefit the population. Mortality could occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs. The expansion of habitat opportunities will allow increased expression of life-history variation and the restoration of an additional population of spring-run Chinook salmon population to strengthen resiliency in the Klamath Basin, particularly because passage upstream of Iron Gate Dam would provide access to thermal refugia at groundwater areas (Hamilton et al. 2011).

Cool water temperatures (similar to existing conditions) during the spring would continue to benefit upstream migrating adult and downstream migrant juvenile spring-run Chinook salmon. Warm water temperatures in the fall would continue to be detrimental to juveniles and adults migrating at that time. These effects would be most pronounced for fish migrating through areas upstream of the Scott River.

This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on spring-run Chinook salmon populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-8). The overall effect of the Continued Operations with Fish Passage Alternative on fish disease may be slightly improved but is unlikely to be substantially altered from existing conditions.

It is anticipated that increased habitat availability as a result of the Continued Operations with Fish Passage Alternative the spring-run Chinook salmon population within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity. These increases would confer greater population-level benefits than the expected mortality within the fishways and upstream reservoirs, resulting in overall increases in the viability for spring-run Chinook salmon in the long term.

Significance

No significant impact for spring-run Chinook salmon in the short term

Beneficial for spring-run Chinook salmon in the long term

Potential Impact 4.2.3-9 Effects on coho salmon populations due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Available data suggest that coho salmon were in both mainstem and tributary reaches of the Klamath River upstream to and including Spencer Creek at RM 232.6 (Figure 3.3-1, NRC 2004, as cited in NMFS 2007a, Hamilton et al. 2005). It is not anticipated that under the Continued Operations with Fish Passage Alternative coho salmon would begin to occupy habitat within the Upper Klamath River and connected waterbodies, and therefore there would be no change from the existing condition.

Upper Klamath River – Hydroelectric Reach

Under the Continued Operations with Fish Passage Alternative, coho salmon would be able to access habitat in the Hydroelectric Reach by ascending the fishways associated with each of the dams. Available habitat for coho salmon would be approximately 54 miles with volitional fishways. If trap and haul were implemented to actively transport coho salmon migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 54 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[200], reduced in some part for the propensity of coho salmon to remain in lower

[200] This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

gradient habitat than steelhead (DOI 2007), habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be around 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrating juveniles; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality. Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007).

Coho salmon downstream from Iron Gate Dam belonging to the Upper Klamath River Population Unit would likely migrate above the dam if access was provided by fishways (NMFS 2006a). Over time, access to habitat above Iron Gate Dam would benefit the Upper Klamath River Population Unit by: (a) extending the range and distribution of the species thereby increasing the coho salmon's reproductive potential; (b) increasing genetic diversity in the coho stocks; (c) reducing the species' vulnerability to the impacts of degradation; and (d) increasing the abundance of the coho salmon population (NMFS 2006a).

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows. Under this alternative, the expected overall higher flow releases would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Project and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, upstream passage would provide fish with some refuge from high temperatures because of access to cooler water from tributaries, in addition to the 200 to 250 cfs provided by coldwater springs in the J.C. Boyle Bypass Reach (DOI 2007, FERC 2007, Hamilton et al. 2011).

This alternative would result in continuation of some of the stresses that currently affect coho salmon populations. The presence of the Lower Klamath Project reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist within reservoirs. Although water temperature in the summer upstream of Iron Gate Dam is an issue, the available information shows that water temperature would not preclude coho salmon from successfully using the habitat within the Project Area while the Lower Klamath Project dams are in place (NMFS 2006a). Adult coho salmon enter the Klamath River between late September and mid-December, with peak upstream migration occurring between late October and mid-November, and juvenile coho outmigrate to the ocean beginning in late February, with most outmigration occurring in

April and May. As such, poor water quality (e.g., high water temperatures) in reservoirs would have minor effect on this species.

Under this alternative, suspended and bedload sediment, water quality, and the occurrence of algal toxins would be the same as under existing conditions.

Middle and Lower Klamath River

Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate Dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a). Most coho salmon spawning and rearing takes place within tributaries. Coarsening of the bed could reduce spawning habitat between Iron Gate Dam and Cottonwood Creek over time, which would have little effect on coho salmon except for the few coho salmon from the Upper Klamath River Population Unit that spawn in the mainstem downstream of Iron Gate Dam. Rearing habitat would be expected to remain similar to existing conditions.

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath River downstream from Iron Gate Dam would continue to have seasonally poor water quality related to temperature because of the continued presence of the reservoirs, with their increased hydraulic residence time and thermal mass (Section 3.2.2.2 *Water Temperature*). PacifiCorp's Reservoir Management Plan actions, such as further development and use of an intake barrier/thermal curtain, may slightly reduce water temperatures downstream of Iron Gate Dam, but recent data indicate that only modest 1–2°C (1.8–3.6°F) water temperature improvement is possible using this approach (PacifiCorp 2017). Further, the maximum useable cool water volume in Copco No. 1 Reservoir in summer and the maximum volume of cold water (8°C or less) in Iron Gate Reservoir in summer are limited, such that selective withdrawal from the reservoirs would be anticipated to decrease water temperatures immediately downstream of Iron Gate Dam by only 1 to 2°C in late summer/early fall. PacifiCorp has also noted that the water supply for Iron Gate Hatchery withdraws cold water from the deeper portion of Iron Gate Reservoir, and depleting or exhausting this cold water pool during the summer would have effects on the hatchery that would need to be addressed (PacifiCorp 2014) (see also discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1).

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease for coho salmon under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Ocean Nearshore Environment
The Continued Operations with Fish Passage Alternative is not expected to substantially alter habitat in the estuary, and thus there would be no impact on coho salmon rearing in the estuary.

Summary
In the short term, there would be no impact (no change relative to existing conditions) for coho salmon from the habitat attributes that would be anticipated to affect the population within a short less than five years) time frame.

In the long term (more than five years), the Continued Operations with Fish Passage Alternative could result in alterations in habitat availability which could affect coho salmon. Under the Continued Operations with Fish Passage Alternative, coho salmon would regain access to approximately 54 miles (or 25 miles if trap and haul were used) of mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach, which would benefit the population. Mortality would occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs.

This alternative would result in continuation of some of the stresses that currently affect coho salmon populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, sediment and would continue to contribute to crowding (though to a lesser degree than under the current condition), allowing some conditions favorable for the transmission of fish disease to persist. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on coho salmon populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-9). The overall effect on fish disease of the Continued Operations with Fish Passage Alternative is likely to improve somewhat but is unlikely to be substantially altered from existing conditions.

Despite the continuation of poor conditions for coho salmon downstream of Iron Gate Dam, the Continued Operations with Fish Passage Alternative would benefit the Upper Klamath River Coho Salmon Population Unit (described in Section 3.3.2.1 *Aquatic Species [coho salmon]*) by increasing habitat access. This population would experience a long-term increase in abundance, population spatial structure, and genetic diversity. These increases would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall increases in the viability of coho salmon from the Upper Klamath River population unit in the long term. The Mid-Klamath River, Shasta River, Scott River, Salmon River population units would experience a continuation of existing effects, and the three Trinity River population units, and the Lower Klamath River population units would not be affected. Based on the continuation of existing conditions for populations downstream from Iron Gate Dam, this alternative would be no impact (no change from existing conditions) for the coho salmon from the Mid-Klamath River, Shasta River, Scott River, and Salmon River, three Trinity River population units, and the Lower Klamath River population units in the long term. Due to the benefit to the Upper Klamath River Population Unit, the Continued Operations with Fish Passage Alternative would provide an overall benefit to the Klamath River Basin coho salmon population in the long term.

Significance

No significant impact for coho salmon populations in the short term

Beneficial for coho salmon populations in the long term

Potential Impact 4.2.3-10 Effects on the steelhead population due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Under the Continued Operations with Fish Passage Alternative, steelhead would regain access to the Upper Klamath Basin upstream of J.C. Boyle Reservoir. This would expand the population's distribution to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising 360 miles of additional potentially productive habitat (Huntington 2006, DOI 2007, NMFS 2007a).

Water quality problems (e.g., excessive water temperatures and low dissolved oxygen) that currently occur in the Keno Impoundment/Lake Ewauna during late spring, summer, and early autumn, may challenge steelhead accessing these areas under the Continued Operations with Fish Passage Alternative. As discussed under Section 3.3.5.3 *Water Quality*, in some years poor water quality in the Keno Impoundment/Lake Ewuana reach may prevent the latest migrants of the summer steelhead run and the earlier migrants from the fall run from accessing upstream spawning habitat in these upper reaches. If no upstream trap and haul is provided at Keno, these fish would be likely to spawn in habitat downstream of Keno Dam in the Hydroelectric Reach (described below), or, in the case of fall-run steelhead, hold below the dam until conditions become passable. However, the majority of the summer steelhead adult migration, much of the fall-run adult steelhead migration, and all of the winter adult steelhead migration is anticipated to occur outside the mid-June to mid-November timeframe in which water quality in the Keno Impoundment/Lake Ewuana reach is typically so poor as to present a migration barrier to adult salmonids. Similarly, juvenile outmigration and run-backs also occur outside this timeframe. While seasonal dissolved oxygen in the Keno Impoundment/Lake Ewauna would be expected to improve in furtherance of TMDL implementation throughout the Upper Klamath Basin, it would be speculative at this point to identify either the mechanisms necessary to implement the TMDLs or the timing required to achieve full compliance, thus this EIR assumes that trap and haul around the Keno Impoundment/Lake Ewauna would be needed in years of poor water quality for fish to be able to access habitat upstream of Keno Dam.

This alternative would not result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins in this reach.

Upper Klamath River – Hydroelectric Reach

Implementation of the Continued Operations with Fish Passage Alternative would restore steelhead access to the Hydroelectric Reach by providing fishways associated with each of the Lower Klamath Project dams. Available habitat for steelhead would be approximately 58 miles with volitional fishways. If trap and haul were implemented to actively transport steelhead migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 58 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[201], habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be around 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrating juveniles; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality.

It is likely that steelhead recolonization would occur rapidly, as was observed for similar steelhead populations following fish ladder installation at Landsburg Dam on the Cedar River, Washington (Kiffney et al. 2009), and following removal of Condit Dam on the White Salmon River, Washington (Allen et al. 2016).

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increased base flows, consistent with mandatory conditions (DOI 2007). Under this alternative, the expected overall higher flow releases would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler water temperatures in late fall and winter. Similar to the Proposed Project, the effect would be to increase water temperatures in the J.C. Boyle Bypass Reach during summer and early fall months relative to existing conditions.

Poor water quality conditions in reservoirs, such as high temperatures with low dissolved oxygen, fluctuations in dissolved oxygen, pH, ammonia associated with algal blooms, and microcystin from *Microcystis aeruginosa* blooms would continue to be stressful to fish from June through September (Dunsmoor and Huntington 2006, FERC 2007).

201 This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

Winter steelhead enter and migrate from August to March; thus, poor water quality could have an effect on these fish as they move through reservoirs. Steelhead generally spawn in tributaries, and juveniles typically outmigrate from April through November, but the peak migration occurs from April through June, so most individuals would be likely to avoid poor reservoir water quality.

Middle and Lower Klamath River

Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate Dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a). Current summer steelhead distribution extends from the mouth of the Klamath River upstream to Empire Creek, while winter steelhead are distributed throughout the Lower Klamath River up to Iron Gate Dam (Stillwater Sciences 2010b). Summer and winter steelhead do not spawn in the mainstem Klamath River, nor are they expected to in the future, so spawning habitat would not be affected by alterations to bedload composition downstream from Iron Gate Dam under the Continued Operations with Fish Passage Alternative. Changes to bedload sediment and effects on juvenile rearing and migration would be expected to remain similar to existing conditions.

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease for steelhead under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Nearshore Environment

The Continued Operations with Fish Passage Alternative is not expected to substantially alter steelhead estuarine habitat.

Summary

In the short term, there would be no impact (no change relative to existing conditions) for steelhead from the habitat attributes that would be anticipated to affect the population within a short (less than five years) time frame, such as substantial changes in suspended sediment like those predicted to occur under the Proposed Project (Section 3.3.5.1 *Suspended Sediment*).

In the long term (more than five years), under this alternative, fishways could result in alterations in habitat availability for steelhead. Under the Continued Operations with Fish Passage Alternative, steelhead could regain access to approximately 414 miles (or fewer if trap and haul were used) of mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach, which would benefit the population. FERC (2007) concluded that implementing fish passage would help to reduce adverse effects to steelhead associated with lost access to upstream spawning habitats. Hamilton et al. (2011) also concluded that access to additional habitat in the Upper Klamath River watershed would benefit steelhead runs. Mortality could occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs.

This alternative would result in continuation of some of the stresses that currently affect steelhead populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist (although steelhead are more resistant to *C. Shasta* than other salmonids). Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on steelhead populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-9). The overall effect of the Continued Operations with Fish Passage Alternative on fish disease may be slightly improved but is unlikely to be substantially altered from existing conditions.

It is anticipated that as a result of the increased habitat availability under the Continued Operations with Fish Passage Alternative, the summer and winter steelhead within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity. These increases would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall increases in the viability of summer and winter steelhead in the long term.

Significance

No significant impact for steelhead in the short term

Beneficial for steelhead in the long term

Potential Impact 4.2.3-11 Effects on the Pacific lamprey population due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Available data suggests that Pacific lamprey were in both mainstem and tributary reaches of the Klamath River upstream to and including Spencer Creek at RM 232.6 (Figure 3.3-1, Hamilton et al. 2005). It is not anticipated that under the Continued Operations with Fish Passage Alternative Pacific lamprey would begin to occupy habitat within the Upper Klamath River and connected waterbodies, and therefore there would be no change from the existing condition.

Upper Klamath River – Hydroelectric Reach

Under the Continued Operations with Fish Passage Alternative, Pacific lamprey would be able to access habitat in the Hydroelectric Reach by ascending the fishways associated with each of the dams. Available habitat for Pacific lamprey would be approximately 58 miles with volitional fishways. If trap and haul were implemented to actively transport Pacific lamprey migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 58 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[202], habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be around 28 percent, and 58 percent for downstream migrating ammocoetes (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrants; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality. Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007).

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increased base flows. In addition, passage would provide Pacific lamprey with some refuge from high temperatures by allowing cooler tributaries to flow directly into the mainstem Klamath River, adding to the 200 to 250 cfs provided by coldwater springs in the J.C. Boyle Bypass Reach (DOI 2007, FERC 2007, Hamilton et al. 2011). Under this alternative, suspended and bedload sediment, water quality, water temperature, and the occurrence of algal toxins would continue to be the same as under existing conditions.

Poor water quality conditions in reservoirs, such as high temperatures with low dissolved oxygen, changes in dissolved oxygen, pH, and ammonia associated with algal blooms, and microcystin from *Microcystis aeruginosa* blooms would continue to be stressful from June to September (Dunsmoor and Huntington 2006, FERC 2007), although modest improvements in water quality are expected with continued implementation of Reservoir Management Plan actions (see Section 4.4.2 *Water Quality*). Pacific lamprey adults migrate from winter through spring, while juveniles (age 2 to age 10) outmigrate year-round, with peaks during late spring and fall. Seasonally poor reservoir quality would likely not affect migrating adults but could affect juveniles. Juveniles would be subject to

202 This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch (FERC 2007).

Middle and Lower Klamath River

Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate Dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a). Spawning and rearing habitat for Pacific lamprey downstream of Iron Gate Dam would be expected to remain similar to existing conditions.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Ocean Nearshore Environment

The Continued Operations with Fish Passage Alternative is not expected to substantially alter Pacific lamprey estuarine habitat.

Summary

In the short term, there would be no impact (no change relative to existing conditions) for Pacific lamprey from the habitat attributes that would be anticipated to affect the population within a short (less than five years) time frame, such as substantial changes in suspended sediment like those predicted to occur under the Proposed Project (Section 3.3.5.1 *Suspended Sediment*).

In the long term (more than five years), under this alternative, fishways could result in alterations in habitat availability for Pacific lamprey. Under the Continued Operations with Fish Passage Alternative, Pacific lamprey would regain access to approximately 58 miles of mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach, which would benefit the population. FERC (2007) concluded that implementing fish passage would help to reduce adverse effects to Pacific lamprey associated with lost access to upstream spawning habitats. Mortality would occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs.

This alternative would result in continuation of some of the stresses that currently affect Pacific lamprey populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on Pacific lamprey populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-9).

It is anticipated that, as a result of the increased habitat availability under the Continued Operations with Fish Passage Alternative, the Pacific lamprey population within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity (NMFS 2006a). These increases would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall increases in the viability of Pacific lamprey in the long term.

Significance

No significant impact for Pacific lamprey in the short term

Beneficial for Pacific lamprey in the long term

Potential Impact 4.2.3-12 Effects on the green sturgeon population due to continued operations of the Lower Klamath Project.

Under the Continued Operations with Fish Passage Alternative, conditions in the area occupied by green sturgeon are unlikely to change relative to existing conditions as green sturgeon occur no further upstream than Ishi Pishi Falls, and this alternative does not have substantial effects relative to existing conditions that extend that far downstream (as described in Section 4.4.3.1 *Suspended Sediment* through Section 4.4.3.6 *Aquatic Habitat and Instream Flows*).

Significance

No significant impact for green sturgeon in the short term and long term

Potential Impact 4.2.3-13 Effects on Lost River and shortnose sucker populations due to continued operations of the Lower Klamath Project.

Under the Continued Operations with Fish Passage Alternative, shortnose and Lost River suckers would continue to be subject to seasonally poor water quality and high rates of predation from non-native fish species within Lower Klamath Project reservoirs, as described in Section 3.3.2.1 *Fish Species [Lost River and shortnose suckers]*. However, with little or no successful reproduction (Buettner et al. 2006), populations downstream from Keno Dam contribute minimally to conservation goals and insignificantly to recovery (Hamilton et al. 2011).

Under the Continued Operations with Fish Passage Alternative, Lost River and shortnose sucker would be able to migrate among habitats within Iron Gate, Copco No. 1, and J.C. Boyle Reservoirs. Since upstream migration at Keno Dam is currently possible to some degree with existing facilities (DOI 2007), suckers would potentially have migratory connectivity from the Lower Klamath Project reservoirs to Upper Klamath

Lake and connected waterbodies. Migratory opportunities may increase access to spawning habitat and increase the abundance and resiliency of the sucker populations (Buettner et al. 2006). However, Miller and Smith (1981) claimed that sucker hybridization was most pronounced in the Lower Klamath Project reservoirs, and Markle et al. (2005) reported hybridization between small scale sucker and both Lost River and shortnose suckers in the Hydroelectric Reach. Hybridization is considered by the sucker recovery plan (USFWS 2013) to be a predominate threat to the populations. Hybridization prompted Buettner et al. (2006) and others to caution against supporting migration of individuals from Iron Gate and Copco reservoirs into the Upper Klamath Lake population. If fish passage were to be provided, there is a potential deleterious effect on the population from increased hybridization (USFWS 2013). Under the Proposed Project, Aquatic Resource Measure AR-6 is included to rescue and salvage suckers from Lower Klamath Project reservoirs prior to their removal. However, AR-6 includes genetic testing for hybridization, and sucker salvage and release is to be only into waterbodies isolated from the Upper Klamath Lake Populations to prevent the risk of further hybridization. As the Continued Operations with Fish Passage Alternative would directly connect the reservoirs for fish, no such measures would be possible, and the risk of hybridization within the Upper Klamath Lake sucker population would be increased. No data are available to predict the extent of potential hybridization or whether it hybridization would have a long-term impact on the Lost River and shortnose sucker population. Overall, it is speculative to determine whether increased access to spawning habitat outweigh the increased risk of hybridization, or vice-versa.

The effect of the Continued Operations with Fish Passage Alternative would be no impact for Lost River and shortnose sucker populations in the short term and long term.

Significance

No significant impact for shortnose and Lost River suckers in the short term and long term

Potential Impact 4.2.3-14 Effects on the redband trout population due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Under existing conditions redband trout can migrate through a fish ladder at Keno Dam, and occasionally through a poorly functioning fish ladder at J.C. Boyle Dam (DOI 2007). Under the Continued Operations with Fish Passage Alternative, redband trout would be able to migrate more successfully from the Hydroelectric Reach to the Upper Klamath Basin (Hamilton et al. 2011) than under existing conditions. New fish passage facilities would improve access to Spencer Creek, which provides important spawning habitat and temperature refugia for redband trout (DOI 2007, Buchanan et al. 2011). New upstream fish passage would also improve connectivity of resident redband populations in the mainstem Klamath River to those in Lake Ewauna, the Link River, and Upper Klamath Lake (DOI 2007).

Redband trout under this alternative could be affected by the reintroduction of anadromous fish, including the potential for competition, predation, and exposure to disease, as described for the Proposed Project in Section 3.3.5.9.

Upper Klamath River – Hydroelectric Reach

Fish passage resulting from the Continued Operations with Fish Passage Alternative would allow redband trout to express the seasonal movements and migration patterns that were historically in place, restore population connectivity and genetic diversity, and allow greater use of existing habitat and refugia. Effective fishways at J.C. Boyle would greatly improve connectivity to Spencer Creek. Fish passage at Copco No. 1 and Copco No. 2 dams would restore connectivity throughout the Hydroelectric Reach to Shovel Creek, which provides spawning habitat and temperature refugia (DOI 2007). Passage at Iron Gate Dam would also restore connectivity between populations in the mainstem Klamath River and those in the Copco No. 2 Bypass Reach and in Slide, Scotch, Camp, Jenny, Salt, and Fall creeks, which also provide spawning habitat and temperature refugia (DOI 2007). The existing fish screen and ladder at the J.C. Boyle Dam do not meet current state and federal fish passage criteria and the ladder impairs upstream migration (Administrative Law Judge 2006). Improvements in efficiency to the fishway at J.C. Boyle Dam would result in significant trout population migration above the dam over time (Administrative Law Judge 2006). As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within all the fishways is predicted to be approximately 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs would have much lower morality. The same is true for downstream migrants; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality. This is especially true for redband trout, which may only migrate past one facility to gain access to spawning habitat, and thus may experience mortality during migration of less than 5 percent (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007).

Under the Continued Operations with Fish Passage Alternative, redband trout would continue to be subject to seasonally poor water quality and high rates of predation from non-native fish species within Lower Klamath Project reservoirs, as described in Section 3.3.2.1 *Fish Species [Redband trout]*. Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increased base flows.

Summary

In the short term, there would be no meaningful impact (relative to existing conditions) for redband trout.

In the long term, fishways at the Lower Klamath Project dams and changes in operations could result in alterations in habitat availability and suitability which could affect redband trout. The Continued Operations with Fish Passage Alternative would improve habitat connectivity throughout the Hydroelectric Reach and to the upper Klamath River in the long term, increasing access to spawning habitat and temperature refugia. Redband trout would still be subject to seasonally poor water quality, and some level of predation within the reservoirs, but increases in connectivity and reduced effects of hydropower peaking operations would likely provide a benefit to redband trout populations. The habitat improvements and increased connectivity would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall benefits to redband trout in the long term.

Significance

No significant impact for redband trout in the short term

Beneficial for redband trout in the long term

Potential Impact 4.2.3-15 Effects on the eulachon population due to continued operations of the Lower Klamath Project.

Under the Continued Operations with Fish Passage Alternative, the extent and quality of eulachon habitat would be expected to remain the same as existing conditions. As eulachon occur far downstream (more than 150 river miles downstream) in the river from the Hydroelectric Reach, mixing and inflows from intervening tributaries would continue to reduce seasonally poor water quality conditions originating in the Lower Klamath Project dams. The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for eulachon in the short term and long term.

Significance

No significant impact for eulachon in the short term and long term

Potential Impact 4.2.3-16 Effects on the longfin smelt population due to continued operations of the Lower Klamath Project.

Under the Continued Operations with Fish Passage Alternative, the extent and quality of longfin smelt habitat would be expected to remain the same as existing conditions. As longfin smelt occur far downstream (more than 150 river miles downstream) in the river from the Hydroelectric Reach, mixing and inflows from intervening tributaries would continue to reduce seasonally poor water quality conditions originating in the Lower Klamath Project dams. The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for longfin smelt in the short term and long term.

Significance

No significant impact for longfin smelt in the short term and long term

Potential Impact 4.2.3-17 Effects on species interactions between introduced resident fish species and native aquatic species due to continued operations of the Lower Klamath Project.

Introduced fish species threaten the diversity and abundance of native fish species through competition for resources, predation, interbreeding with native populations, and causing potential physical changes to the invaded habitat (Moyle 2002). Introduced resident species occur within reservoirs upstream of Iron Gate Dam, and infrequently downstream from Iron Gate Dam. . Adults yellow perch are opportunistic predators that feed on small fish, potentially including native fish species. Juvenile and adult largemouth bass tend to feed on larger invertebrates and fish as well, potentially including native species. Under the Continued Operations with Fish Passage Alternative, dams in the Hydroelectric Reach would not be removed, allowing reservoir habitat to remain the same as existing conditions. Additionally, anadromous fish that are now prevented from entering the reservoirs would be able to do so. However, connectivity between the reservoirs could increase access to available habitat area for introduced species as well as native species if they are able to migrate through volitional passage facilities. Migratory connectivity is more likely to increase the population abundance and resiliency of native species adapted to more riverine conditions, than reservoir-dependent non-natives. Juvenile native species migrating through reservoirs would be subject to some level of predation by introduced resident species resulting in mortality rates that would depend largely on their size (larger migrants would do better)

(NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018). Based on the reservoir dynamics and the predator population that currently occurs, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (NMFS 2006a). In restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (NMFS 2006a). Overall, the effect of the Continued Operations with Fish Passage Alternative would be less than significant for the effects of introduced resident species on native aquatic species. If passage were provided through trap and haul, these interactions would be further reduced, as fewer juvenile anadromous fish would enter Copco No. 1, Copco No. 2 and Iron Gate reservoirs.

Significance

No significant impact for the effects of introduced resident species on native aquatic species

Potential Impact 4.2.3-18 Effects on aquatic species from interactions among fish species due to continued operations of the Lower Klamath Project.

The Continued Operations with Fish Passage Alternative would restore access for migratory fish species to habitat upstream of Iron Gate Dam, as described in detail above. As described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-18), restoration of access would result in Pacific lamprey, anadromous salmon, and steelhead potentially interacting with resident redband trout and bull trout, with the potential for competition and predation. These species evolved together in the Upper Klamath Basin of the Klamath River, and co-existed prior to the construction of dams (Goodman et al. 2011).

Anadromous salmonids currently co-exist with resident rainbow trout and resident cutthroat trout downstream from Iron Gate Dam, without any obvious detriment to these native species or the aquatic ecosystem in which they reside. While there is little information on the nature of any competitive interactions between steelhead and resident trout in the Klamath Basin, research does suggest that in some circumstances, resident trout may have a competitive edge over steelhead (NMFS 2006a). Conversely, research has shown that hatchery salmon supplementation can negatively impact resident trout abundance and salmonid biomass in a Washington watershed (Pearsons and Temple 2010). However, competition between steelhead and currently present indigenous species such as redband trout are not assumed to be a major limiting factor since these species historically co-evolved (Hooton and Smith 2008). There are many examples from nearby river systems in the Pacific Northwest that show wild anadromous steelhead and resident rainbow/redband trout can co-exist and maintain abundant populations without adverse consequences. The Deschutes River in Oregon, the Yakima River in Washington, and the river systems in Idaho are examples (NMFS 2006a). As noted by Buchanan et al. (2011a), existing trout and colonizing anadromous steelhead are expected to co-exist in the Klamath Basin, as they do in other watersheds, although there may be shifts in abundance related to competition for space and food. Overall, there is no predicted substantial short-term or long-term decrease in native aquatic species abundance of a year class, or substantial decrease in habitat quality or quantity, and there would not be a significant impact to the aquatic species populations under the Continued Operations with Fish Passage Alternative in the short term or long term.

Significance
No significant impact for effects to aquatic species from interactions among fish species in the short term and long term

Potential Impact 4.2.3-19 Effects on freshwater mollusks populations due to continued operations of the Lower Klamath Project.
Under the Continued Operations with Fish Passage Alternative, suspended sediment, algal toxins, and other dynamics that potentially affect freshwater mussels would not change substantially from existing conditions, since only modest improvements in water quality are expected with continued implementation of actions contained within PacifiCorp's Reservoir Management Plan (see Section 4.4.2 *Water Quality*). The Continued Operations with Fish Passage Alternative would therefore have no significant impact as compared to the existing condition on mussels in the short term and long term.

Significance
No significant impact for freshwater mussels in the short term and long term

Potential Impact 4.2.3-20 Effects on fish species from alterations to benthic macroinvertebrates due to continued operations of the Lower Klamath Project.
Benthic macroinvertebrates (BMI) are small aquatic animals and the aquatic larval stages of insects. BMI are the primary food source for most freshwater fish species, and therefore, changes in abundance, distribution, or community structure can affect fish populations. A diminished food supply can limit growth of salmonids, and this is especially true at higher temperatures because as water warms, a fish's metabolic rate increases, and it needs more food to sustain growth. Growth is critical to juvenile salmonids because a larger size fish often has a survival advantage during the overwintering period, smolt outmigration, and ocean residence.

Under the Continued Operations with Fish Passage Alternative, reduction in peaking operations in the Hydroelectric Reach would result in a reduction in periodic killing, through stranding, of large numbers of young fish and aquatic invertebrates that are the primary prey food for salmonids (Administrative Law Judge 2006). Increased minimum flows in the bypass reaches may increase BMI production. This would result in a benefit to food availability both for the trout and other fish currently in the reach, and for anadromous species gaining access to the reach.

While the additional flows under this alternative would periodically increase the mobility of existing surficial fine sediment deposits downstream of Iron Gate Dam, in general, suspended sediment, which can affect benthic macroinvertebrates as discussed for the Proposed Project in Section 3.3.5.9, Potential Impact 3.3-20, would also be the same as under existing conditions. Further, since only modest improvements in water quality are expected with continued implementation of actions contained within PacifiCorp's Reservoir Management Plan (see Section 4.4.2 *Water Quality*), the effect of the Continued Operations with Fish Passage Alternative would be no significant impact (no change from existing conditions) on fish species due to alterations to benthic macroinvertebrates in the short term and long term.

Significance
No significant impact for effects of alterations to benthic macroinvertebrates on fish species in the short term and long term

Potential Impact 4.4.3-1 Effects on aquatic resources due to short-term noise disturbance and water quality alterations from fishway construction activities. This analysis relates to the potential impacts to aquatic resources from various construction activities associated with fishways under the Continued Operations with Fish Passage Alternative.

Disturbance to the river channel during construction related to the Continued Operations with Fish Passage Alternative could affect aquatic species. This alternative would require removal of the existing J.C. Boyle fish ladder structure, construction of a new fishways at all dams (Figure 2.3-1), and construction of downstream fish passage at all dams. Fish ladder construction would include building upstream fish ladders, spillway modifications, tailrace barriers, screens, and bypass structures (see Appendix U of this EIR for more details). These actions would include the use of heavy equipment, and blasting as necessary, and have the potential to disturb aquatic species. Activities at the Lower Klamath Project dams would affect the riverine and reservoir species in the Hydroelectric Reach. At Iron Gate Dam and Iron Gate Hatchery, anadromous species could also be affected. These potential effects could include shockwaves associated with construction of fish ladders using heavy equipment, potential crushing of aquatic species from operation of heavy equipment in the river, sedimentation, and release of oil, gasoline, or other toxic substances from construction sites.

Although the duration of construction for any individual facility would range from approximately four months to one year (Table 4.4-1), the entire process of installing fish passage at each of the four Lower Klamath Project dams would take place over a four- to eight--year period (FERC 2007). Unlike under the Proposed Project, these construction activities would not necessarily be limited to the timeframe that generates the least impact on the various life stages of anadromous fish in the Klamath River (i.e., winter and spring months), although since downstream facilities would be installed prior to upstream passage facilities, anadromous fish potentially would not be exposed to construction impacts related to building the downstream facilities.

As some of the construction activities under this alternative would occur directly in the river channel (i.e., "in-water") or on the banks immediately surrounding the river, the potential for impacts to aquatic species are greater than for work conducted in areas that can be dewatered or dried. To minimize potential construction impacts from crushing, sediment release, toxins, noise, etc., construction areas would be isolated from the river where possible. Areas to be dewatered would be isolated, and fish rescue and relocation efforts would be undertaken to remove any native fish trapped in the work area. Fish would be relocated to an area of suitable habitat within the Klamath River.

Implementation of mitigation measures WQ-1 and HZ-1 would reduce impacts to less than significant for fish passage construction-related activities in the Hydroelectric Reach throughout the four- to eight-year construction period under the Continued Operations with Fish Passage Alternative. If instead of fish ladders, trap and haul, or some combination of fish passage methods were used, there would be the potential for reduced construction compared to the aforementioned activities for fish ladders (see also Section 4.4.1 *[Continued Operations with Fish Passage Alternative] Introduction*).

Based on no predicted substantial short- or long-term decrease in in the abundance of a year class of any aquatic species, or substantial decrease in habitat quality or quantity for any aquatic species, there would not be a significant impact to aquatic resources under the Continued Operations with Fish Passage Alternative in the short term or long term from fishway construction impacts.

Significance

No significant impact with mitigation in the short term or long term

4.4.4 Phytoplankton and Periphyton

4.4.4.1 Phytoplankton

As discussed in more detail in Section 3.4, phytoplankton are aquatic microscopic organisms, including algae, bacteria, protists, and other single-celled plants, that obtain energy through photosynthesis and float in the water column of still or slowly flowing waters such as lakes or reservoirs. Excess growth of these organisms can cause nuisance water quality conditions, such as extreme diel (daily) fluctuations in dissolved oxygen and pH (see Section 3.4.2.1 *Phytoplankton* for detail. Under the Continued Operations with Fish Passage Alternative, reservoir sediment deposits would not be mobilized in the Hydroelectric Reach, Middle and Lower Klamath River, or the Klamath River Estuary, and there would be no short-term increases in sediment-associated nutrients that could potentially stimulate nuisance and/or noxious phytoplankton growth in those reaches (Potential Impact 3.4-1), and thus there would be no significant impact.

Nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions with respect to long-term phytoplankton blooms in the reservoirs. Additionally, PacifiCorp intends to design and implement a Reservoir Management Plan, which would result in some differences between this alternative and existing conditions. These differences are discussed below (Potential Impact 4.4.4-1).

Potential Impact 4.4.4-1 Long-term occurrence of nuisance and/or noxious phytoplankton blooms in the reservoirs.

Because the Lower Klamath Project reservoirs would remain in place, Copco No. 1 and Iron Gate reservoirs would continue to provide beneficial habitat conditions for the proliferation of large seasonal blooms of *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, and *Microcystis aeruginosa*, which subsequently become the source of these species to the Middle and Lower Klamath River, and eventually the Klamath River Estuary (see also Section 3.4.2.3 *Hydroelectric Reach*). Note that the increase in minimum flows for the Copco No. 2 Bypass Reach under this alternative could increase summertime phytoplankton concentrations in the Bypass Reach relative to existing conditions if the water were to be withdrawn from the Copco No. 1 Reservoir surface waters during an intensive bloom period, however this potential is too speculative to evaluate further.

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impact 4.2.2-4, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including seasonal increases in TP, and to a lesser degree TN, in the Hydroelectric Reach due to the release (export) of dissolved forms of phosphorus (ortho-phosphorus) and nitrogen (ammonium) from Copco No. 1 and Iron Gate reservoir sediments during summer and fall, when reservoir bottom waters are anoxic (through internal nutrient loading, see

Figure 3.2-2). The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6 do not indicate that this measure could reduce the extent of phytoplankton blooms in the reservoirs such that they would no longer cause large seasonal blooms of *Microcystis aeruginosa*. Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial with respect to decreasing nuisance phytoplankton blooms. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions are likely to require decades to achieve. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs and overall there is currently no reasonable proposal to substantially reduce nuisance and/or noxious phytoplankton blooms, including *Microcystis aeruginosa*, in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months (Potential Impact 3.4-2), which subsequently become the source for the Middle and Klamath River, and Klamath River Estuary. The Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions in the short term and long term for these reaches. With respect to the Pacific Ocean nearshore environment, the latter is not suitable habitat for the freshwater phytoplankton species of concern (i.e., *Aphanizomenon flos-aquae, Anabaena flos-aquae, Microcystis aeruginosa*) (Potential Impact 3.4-2), and leaving the dams in place under the Continued Operations with Fish Passage Alternative would result in no significant impact relative to existing conditions.

<u>Significance</u>
No significant impact in the long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

4.4.4.2 Periphyton

As discussed in more detail in Section 3.4 *Phytoplankton and Periphyton*, periphyton are aquatic organisms including aquatic plants, algae, and bacteria that live attached to underwater surfaces such as rocks on a riverbed. Some degree of periphyton growth is an important part of stream ecosystem function. Excess growth of these organisms can cause nuisance water quality conditions, such as extreme diel (daily) fluctuations in dissolved oxygen and pH (see Section 3.4.2.2 *Periphyton* for detail). Under the Continued Operations with Fish Passage Alternative, reservoir sediment deposits would not be mobilized in the Hydroelectric Reach, Middle and Lower Klamath River, or the Klamath River Estuary, and there would be no short-term increases in sediment-associated nutrients that could potentially stimulate nuisance periphyton growth in those reaches (Potential Impact 3.4-4), and thus there would be no significant impact.

The Continued Operations with Fish Passage Alternative would change the flow regime downstream of J.C. Boyle Dam, Copco No. 2 Dam, and Iron Gate Dam. These differences are discussed below (Potential Impact 4.4.4-2).

Potential Impact 4.4.4-2 Long-term colonization of nuisance periphyton in riverine reaches.
The Continued Operations with Fish Passage Alternative would change the flow regime downstream of J.C. Boyle Dam. This alternative would have the same or similar potential short-term and long-term impacts on periphyton in the Hydroelectric Reach

from the Oregon-California state line to Copco No. 1 Reservoir as those identified for the Proposed Project (Potential Impact 3.4-4). This is because increased minimum flows in the J.C. Boyle Bypass Reach and reduction of peaking operations at J.C. Boyle Powerhouse to one day per week, would result in a similar flow regime in the California portion of the Peaking Reach as that described under the Proposed Project, and it is these flow regime changes that have the potential to increase periphyton habitat. There would be less artificial diel (24-hour) temperature variation during summer and early fall in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir relative to existing conditions (see also Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality,* Potential Impact 4.2.2-1). J.C. Boyle Reservoir retains relatively little nutrients under existing conditions (see Appendix C, Section C.3.1.1 *Hydroelectric Reach*), and therefore nutrient conditions in this reach would be the same under the Continued Operations with Fish Passage Alternative as under existing conditions since there would be no change in nutrient interception or retention with J.C. Boyle Dam remaining in place (see also Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impact 4.2.2-4). The less diel (24-hour) temperature variations and slight decrease in the maximum water temperature in this reach is not anticipated to affect periphyton colonization. Additionally, the generally high gradient and velocity in the J.C. Boyle Peaking Reach does not currently support excessive periphyton mats and it is not anticipated this reach would support excessive periphyton mats under higher minimum flows and reduce peaking flows. In the short term and long term, increases in periphyton biomass from reduction of peaking flows along with the change in water temperature in this reach are expected to be limited under the Continued Operations with Fish Passage Alternative and any potential increase in periphyton would not result in new or further impairment of designated beneficial uses. For the reasons described above, increased minimum flows and reductions in peaking flows in the Copco No. 2 Bypass Reach under this alternative also would not result in new or further impairment of designated beneficial uses due to periphyton growth. Overall, in the Hydroelectric Reach there would be no significant impact.

Further downstream, the continuing presence of the Lower Klamath Project dams would continue to support periphyton growth in the Middle and Lower Klamath River as described for existing conditions (Section 3.4.2.4 *Middle and Lower Klamath River*), with the exception that the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam under this alternative would scour the streambed more regularly than under simply the 2013 BiOp Flows that characterize the existing condition. This is likely to reduce dense growth of periphyton in the Middle Klamath River from Iron Gate Dam to approximately the Shasta River confluence (RM 179.5) relative to existing conditions, even as the contribution of the hydroelectric facilities to such nuisance growth remains unchanged, and would be beneficial (see also Potential Impact 4.2.4-1).

PacifiCorp intends to design and implement a Reservoir Management Plan to reduce water quality impairments in the Hydroelectric Reach and immediately downstream of Iron Gate Dam, including seasonal release of nutrients from Copco No. 1 and Iron Gate reservoir sediments during summer and fall, when reservoir bottom waters are anoxic. As described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impact 4.2.2-4, results of Reservoir Management Plan studies to date do not indicate that reduced seasonal nutrient releases from the reservoirs would occur under this alternative. Nutrient reduction measures in Oregon and California’s TMDLs would, over time, be beneficial with respect to decreasing overall nutrient concentrations in the

Middle and Lower Klamath River. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions are likely to require decades to achieve. However, because nutrients do not appear to be limiting periphyton growth in the Klamath River from Iron Gate Dam to approximately Seiad Valley (RM 132.7) (and potentially farther downstream) (see also Potential Impact 3.4-5), nutrient dynamics associated with the Continued Operations with Fish Passage Alternative are not likely to have an effect on periphyton growth in the Middle and Lower Klamath River, such that there would be no new or further impairment of designated beneficial uses.

Overall, the increased scouring of the streambed due to 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would reduce dense growth of periphyton in the Middle Klamath River relative to existing conditions, and would be beneficial.

Significance

No significant impact for the Hydroelectric Reach

Beneficial for the Middle Klamath River from Iron Gate Dam to the Shasta River (RM 179.5)
No significant impact for the Middle Klamath River downstream of the confluence with the Shasta River (RM 179.5) and the Lower Klamath River

4.4.5 Terrestrial Resources

4.4.5.1 Vegetation Communities

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to facilitate upstream and downstream fish ladders, at all four Lower Klamath Project dam complexes. These activities would have a reduced construction footprint as compared to that necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project, as fewer structures would be removed and less debris created. These activities would take place within the Limits of Work for the Proposed Project, thus construction-related impacts on wetland and riparian vegetation would generally be similar to, but less than those described for the Proposed Project. As described in Section 3.5.5.1, construction activities resulting in ground disturbance would have short-term impacts on sensitive habitats, including wetlands and riparian habitats along reservoirs and river reaches. Within the construction footprint of the fishways, implementation of Mitigation Measure TER-1 described in Potential Impact 3.5-1 and Mitigation Measure TER-5, would reduce potential short-term construction impacts on sensitive habitats to less than significant.

Implementation of mitigation measures TER-1 and TER-5 would be enforceable through inclusion in a water quality certification and construction-related impacts on wetlands and riparian vegetation communities with mitigation would be reduced for the reasons described in Section 3.5.5.1 *Terrestrial Resources Potential Impacts and Mitigation*. Therefore, construction impacts on wetlands and riparian communities, would be less than significant with mitigation.

Under the Continued Operations with Fish Passage Alternative there would be no impact on wetland and riparian vegetation resulting from short- or long-term habitat loss or gain as compared with existing conditions, since reservoir drawdown and dam removal activities would not occur (Potential Impacts 3.5-2, 3.5-3, 3.5-4, 3.5-5, and 3.5-8).

Mitigation Measure TER-5 – Identification, protection, and restoration of wetland and riparian habitats.
The KRRC shall conduct a wetland delineation within the limits of construction in accordance with the 1987 U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual (USACE 1987) and applicable Regional Supplements (i.e., Western Mountains, Valleys, and Coast Region [USACE 2010] and Arid West [USACE 2008]). The results of the wetland delineation shall be incorporated into the Continued Operations with a Continued Operations with Fish Passage Alternative design to avoid and minimize direct impacts on wetlands to the maximum extent feasible, and wetland areas adjacent to the construction Limits of Work shall be fenced to prevent inadvertent entry. Where avoidance is not feasible the KRRC shall develop a restoration plan to re-vegetate all areas disturbed during construction with a goal of no net loss of wetland or riparian habitat acreage and functions. The restoration plan shall include details on revegetation native seed mixes based on existing species that will be impacted and installation techniques for container plants and seeds. Wetlands established in restored areas would be monitored for five years or until the performance criteria, as defined in the restoration plant that shall be developed, have been met.

4.4.5.2 Culturally Significant Species

As described in Section 3.5.2.3 many of the species identified by the Native American Tribes in the Klamath River region as culturally significant occur in riparian and wetland habitats. Under the Continued Operations with Fish Passage Alternative, required construction activities including facility development for the fishway prescriptions would result in less ground disturbance than those needed for removal of the Lower Klamath Project dam complexes under the Proposed Project as a result of removing less structures and creating less debris; however, because ground disturbance would occur, the types of potential short- and long-term construction-related impacts on culturally significant species would be similar to those described for the Proposed Project (Potential Impact 3.5-6). Mitigation Measure TER-1 (see Potential Impact 3.5-1) and TER-5 includes wetland buffers to prevent intrusion in wetland habitats, avoid substantial degradation in these areas, and restore with a goal of no net loss of wetland or riparian habitat acreage and function. These measures would reduce short- and long-term impacts on culturally significant species to less than significant under this alternative. Implementation of the TER-1 and TER-5 measures would be enforceable through inclusion in a water quality certification. Therefore, the TER-1 and TER-5 measures are feasible and Potential Impact 3.5-6 would result in no significant impacts from impacts on culturally significant species in riparian and wetland habitats with mitigation for the reasons described in Section 3.5.5.2 *Terrestrial Resources Potential Impacts and Mitigation*.

4.4.5.3 Special-status Species

Under the Continued Operations with Fish Passage Alternative, construction activities for fish passage facilities would constitute major construction in the Limits of Work described in Section 4.4.1. Special-status plant and wildlife species in the Primary Area of Analysis are listed/described in Tables 3.5-4 and 3.5-5. The types of potential short- and long-term construction-related impacts on terrestrial resources would be similar to those described for the Proposed Project (Potential Impacts 3.5-7, 3.5-9, 3.5-10, 3.5-11, 3.5-12, 3.5-13, 3.5-14, 3.5-28), but would be somewhat less than under the Proposed Project, as there would be less construction-related ground disturbance from the development of fish ladders or trap and haul as compared with removing the dam complexes. As a result, there would be relatively less overall habitat modification and less intensive construction noise due to modifying fewer structures under this alternative as compared with the Proposed Project. However, the entire process may take place over a four- to eight-year period which would result in noise disturbance (potentially from blasting) over a longer period of time to affect terrestrial resources.

Even though there would be less construction activity under the Partial Removal Alternative as compared to the Proposed Project, special-status plants and rare natural communities may be present in the areas where construction activities may be performed. Consequently, short-term impacts on special-status plants and rare natural communities may would be similar to those of the Proposed Project (Potential Impact 3.5-7), though at a reduced scale. Within the construction footprint of the fishways, Recommended Terrestrial Resource Measure TER-1 and measures similar to those described in Appendix B: *Definite Plan – Appendix J* would be required to reduce potential impacts, including surveys for special-status species and rare natural communities, implementation of avoidance measures and invasive species control. To the extent the special-status plants and rare natural communities are a part of wetland or riparian areas, these measures can be feasibly imposed through water quality certification. For other such communities, however, it is not clear whether the hydroelectric project owner or operator would implement the Recommended Terrestrial Measures TER-1 (Potential Impact 3.5-7) or measures similar to those described in the Appendix B: *Definite Plan – Appendix J* through 'good citizen' agreements, as described in the Definite Plan, and it is unclear how these recommended terrestrial measures would be enforced in light of Federal Power Act preemption. Without an enforcement mechanism, these restoration activities cannot be deemed feasible for the purposes of CEQA. Therefore, construction impacts on special-status plants and rare natural communities would be significant and unavoidable.

A reduction in the impacted area as compared to the impacts of the Proposed Project, could reduce the significance of the impact to special-status wildlife species, specifically state species of special concern or BLM sensitive species on BLM lands, because it would reduce the number of potentially affected individuals in a population (Potential Impact 3.5-9). However, for other special-status wildlife species (state listed, state proposed, USFWS listed), it would not reduce the significance of the potential impact, because the significance criteria rely on impacts on a single individual, and this risk remains. For example, removing or modifying fewer structures and eliminating or shrinking the footprint of disposal sites would reduce the chances that construction would occur in an area that would impact special-status bird nests. Large bat maternity roosts have been documented at structures that would be retained under this alternative including Copco No. 1 Dam – C12 Gate house, Copco No. 1 Diversion Tunnel, and Iron Gate Diversion tunnel, and retaining these structures would be the same as existing conditions and reduce population-level impacts on bats compared to the Proposed Project (Potential Impact 3.5-14). However, if state, federal, or proposed-listed bird nests or hibernacula or maternity roosts are within the range of the lesser amount of construction, impacts would still be the same vis-à-vis on those birds or bat colonies and would still be potentially significant.

Compared to the existing condition, the substantial construction involved with constructing fish passage facilities would have the potential to significantly impact special-status wildlife species for the reasons described above and in Section 3.5.5 (Potential Impacts 3.5-10, 3.5-11, 3.5-12, 3.5-13, 3.5-14, and 3.5-28). Implementation of Mitigation Measures TER-2 and TER-3 would reduce construction-related impacts, including in-water work, on all special-status amphibian species to less than significant. Implementation of Recommended Terrestrial Measures 3–12 would reduce impacts on special-status birds and mammals to less than significant. Implementation of the TER-2 and TER-3 measures would be enforceable through inclusion in a water quality certification. Therefore, the TER-2 and TER-3 measures are feasible and Potential Impact 3.5-10 would result in no significant impacts on amphibian and reptile with mitigation from construction-related impacts and Potential Impact 3.5-28 impacts would be reduced for the reasons described in Section 3.5.5.3 *Terrestrial Resources Potential Impacts and Mitigation*. It is not clear, however, whether the hydroelectric project owner or operator would implement the Recommended Terrestrial Measures 3–12 (Potential Impacts 3.5-10, 3.5-11, 3.5-12, 3.5-13, 3.5-14, and 3.5-28) through 'good citizen' agreements, as described in the Definite Plan, and it is unclear how these recommended terrestrial measures would be enforced in light of Federal Power Act preemption. Without an enforcement mechanism, these restoration activities cannot be deemed feasible for the purposes of CEQA. Therefore, this impact on special-status birds, and mammals would be significant and unavoidable.

Since Iron Gate Hatchery operations would not change under the Continued Operations with Fish Passage Alternative, there would be no potential impacts on special-status plant and wildlife species related to changes in hatchery operations (Potential Impact 3.5-26).

Short-term impacts of elevated SSCs in the mainstem Klamath River from reservoir drawdown and dam removal would not occur under the Continued Operations with Fish Passage Alternative since the dams would remain in place and no drawdown would occur (Potential Impacts 3.5-16 and 3.5-18).

There would be no impact resulting from long-term habitat loss (or beneficial gain for willow flycatcher) as compared to existing conditions, since the reservoirs would remain and would continue to provide habitat for western pond turtle, many species of birds, including waterfowl and bald eagles, bats, and other special-status wildlife and plants that are supported by aquatic habitat provided by the reservoirs (Potential Impacts 3.5-21 and 3.5-22). However, fish passage would allow for nutrient distribution upstream of Iron Gate Dam, for reasons described for the Proposed Project (Potential Impact 3.5-30). Additional flow releases in the Middle Klamath River (downstream of Iron Gate Dam) would occur to address the conditions associated with fish disease, and impacts from these (2017) court-ordered flows on foothill yellow-legged frog breeding, if present, would be significant and unavoidable for reasons described for the No Project Alternative (Potential Impact 4.2.5-1) in both the short term and the long term. Potential impacts on western pond turtle would be less than significant for reasons described for the No Project Alternative (Potential Impact 4.2.5-1) in both the short term and the long term.

Under the Continued Operations with Fish Passage Alternative, there would be increased minimum flows in the J.C. Boyle Bypass Reach and peaking operations at J.C. Boyle Powerhouse in Oregon would be limited to one day per week. The habitat differences from these actions would be more muted in California, as they are attenuated with distance downstream due to tributary inputs and accretion flows, but, as described in Section 3.2.4, there would be slightly lower maximum water temperatures, and less artificial diel temperature variation during summer and early fall (Potential Impact 3.2-1). Thus, the temperature and flow regime would move towards a more natural condition than that under the existing condition, reducing the stressors to amphibian and reptile species located there. Increases in minimum flows for the Copco No. 2 bypass reach, with a release of 70 cfs or inflow, whichever is less, to the bypass reach would occur; this increase would not affect special-status amphibians or reptiles if present. Thus, there would be no dam-related downstream flow fluctuations below the Copco No 2. or the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir that could otherwise adversely impact amphibian or reptile species located there. Retaining the Lower Klamath Project dams would likely prevent any upward movement of the foothill yellow-legged frog into this reach and as a result no impact on foothill yellow-legged frog is anticipated. A slight decrease in the maximum water temperature in this reach is not anticipated to other wildlife species (e.g., western pond turtle). There would be no impact on special-status wildlife species in California due to the increased minimum flows and limited hydropower peaking flows originated from J. C. Boyle Dam in Oregon or Copco No. 2 Dam operations.

4.4.5.4 Wildlife Corridors and Habitat Connectivity

Under the Continued Operations with Fish Passage Alternative, the reservoirs and dams would continue to present a barrier or hindrance to movement for some terrestrial wildlife species such and amphibians, reptiles, mammals, and riparian birds, as described under Section 3.5.2.6 *Environmental Setting, Wildlife Corridors and Habitat Connectivity*. (Potential Impacts 3.5-19, 3.5-23). With the fishway prescription, salmon and other fish species would be able to access reaches upstream of Iron Gate Dam, and thus would provide nutrient-rich food for terrestrial species located there. Marine-derived nutrients would be subsequently deposited into terrestrial habitats and productivity of the terrestrial ecosystem as a whole could improve from existing conditions, although not to the extent described for the Proposed Project in Potential Impacts 3.5-24 and 3.5-25, because of because of the difference in migration success through fishways and reservoirs compared to through a riverine system. There would be no impact compared with existing conditions.

4.4.6 Flood Hydrology

Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect flood hydrology, and therefore would present no change from the existing condition. Flow increases in the J.C. Boyle and Copco No. 2 bypass reaches are related to minimum instream flows and would not impact peak flows during flood events.

4.4.7 Groundwater

Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect groundwater, and therefore would present no change from the existing condition.

4.4.8 Water Supply/Water Rights

Flow increases in the J.C. Boyle and Copco No. 2 bypass reaches are related to minimum instream flows in the Hydroelectric Reach and would not impact water supply or water rights downstream of Iron Gate Dam. Similarly, there would be no changes to water supply/water rights related to the 2017 flow requirements, which is discussed in detail in Potential Impact 4.2.8-1. Overall, the Continued Operations with Fish Passage Alternative would not affect water supply/water rights as compared with the existing condition.

4.4.9 Air Quality

Under the Continued Operations with Fish Passage Alternative, construction activities to install fish ladders would occur at all four Lower Klamath Project dam complexes. Construction activities would result from the development of structures to support these fish passage options; however, the overall area of ground disturbance would be reduced as less structures would be removed and less debris would be created as compared to the Proposed Project (see also Section 4.4.1 *[Continued Operations with Fish Passage Alternative] Alternative Description*) Under this alternative, fugitive dust emissions would be caused by movement of construction equipment on the soil and internal haul roads and a small amount of cut/fill activities. As construction activities required for implementing fish passage would be less than those necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project, the level of overall construction activities and thus peak daily emissions of air pollutants (i.e., VOCs, CO, NOx, SOs, PM_{10}, $PM_{2.5}$) in the Hydroelectric Reach in California would be less than those described under the Proposed Project (Potential Impact 3.9-1). Further, since the construction activities may occur over a period of four to eight years for all of the fish passage facilities, the estimated maximum daily emissions would be less than the subtotal of activities for each dam (Table 4.4-2). Construction-related emissions would not exceed the Siskiyou County Air Pollution Control District's (SCAPCD) thresholds of significance in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants) for the Continued Operations with Fish Passage Alternative.

Table 4.4-2. Summary of Peak Daily Emissions (pounds per day)[1,2] for Construction Activities for the Continued Operations with Fish Passage Alternative.

Dam	Peak Daily Emissions (pounds per day)[1,2]					
	VOC	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Iron Gate Subtotal	11	63	59	<1	8	3
Copco No. 1 Subtotal	9	51	37	<1	2	1
Copco No. 2 Subtotal	10	58	50	<1	5	2
J.C. Boyle Subtotal	9	16	50	4	11	6
Maximum Daily Emissions	11	63	59	4	11	6
Significance Criterion	250	2,500	250	250	250	250

1 Data from 2012 KHSA EIS/EIR.
2 Breakdown of peak daily emissions associated with types of construction activities under the Continued Operation with Fish Passage Alternative is provided in Appendix N, Table N-16.

Key:

VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides

SO_x = sulfur oxides
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

This alternative would not include operational changes that would affect air emissions in the long term for implementation of fish ladders and there would be no significant impact (Potential Impact 3.9-1).

If trap and haul facilities were to be constructed instead of fish ladders, peak daily emissions due to construction activities would be less than those described above. Long term trap and haul operations would consist of trapping adult upstream migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir as an ongoing activity. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Iron Gate Dam. Although the exact extent and timing of these ongoing hauling activities is not known, peak daily air quality emissions would be considerably less than those estimated above because it is unlikely that more than ten truck trips per day would be necessary, including a conservative assumption of round trip (i.e., upstream and downstream) hauling for 60 to 70 miles each way between Iron Gate Dam and J.C. Boyle Reservoir. Therefore, the long-term potential impact on air quality emissions due to trap and haul operations would be less than significant.

4.4.10 Greenhouse Gas Emissions

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to facilitate upstream and downstream fishways, which may include installing fish ladders, trap and haul, or experimental fish cannons, at all four Lower Klamath Project dam complexes. This construction would release greenhouse gasses as described under the Proposed Project (Potential Impact 3.10-1). As construction activities required for fish passage facilities would be less than those necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project, uncontrolled direct total GHG emissions from construction under this alternative also would be below the SCAQMD's 10,000 MTCO2e significance threshold and would result in no significant impact.

The Continued Operations with Fish Passage Alternative would not remove a source of renewable power and thus would have no indirect effect on production of greenhouse gas emissions relative to existing conditions (Potential Impact 3.10-2).

If trap and haul facilities were to be constructed instead of fish ladders, greenhouse gas emissions due to construction activities would be less than those described above. Long term trap and haul operations would consist of trapping adult upstream migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir as an ongoing activity. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Iron Gate Dam. Although the exact extent and timing of these ongoing hauling activities is not known, greenhouse gas emissions would be considerably less than those estimated above because it is unlikely that more than ten truck trips per day would be necessary, including a conservative assumption of round trip (i.e., upstream and downstream) hauling for 60 to 70 miles each way between Iron Gate Dam and J.C. Boyle Reservoir. Therefore, the long-term potential impact on greenhouse gas emissions due to trap and haul operations would be less than significant.

4.4.11 Geology, Soils, and Mineral Resources

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders, at all four Lower Klamath Project dam complexes. While these activities would be less than those described for the Proposed Project, there would still be potential for soil disturbance associated with heavy vehicle use, excavation, and grading during the construction of fish passage facilities, which could result in erosion at Iron Gate, Copco No. 2, and J.C. Boyle reservoirs and could exacerbate existing erosion at Copco No. 1 Reservoir (see also Potential Impact 3.11-2). For reasons described for the Proposed Project, implementation of BMPs to prevent erosion during demolition activities would minimize the potential for erosion and sediment delivery into the reservoir areas and there would be no significant impact due to soil disturbance associated with construction activities (Potential Impact 3.11-2).

Increases in minimum flows and decreases in peaking flows due to changes in J.C. Boyle Dam and Copco No. 2 Dam operations, plus the winter-spring surface flushing flows and deep flushing flow requirements at Iron Gate Dam (and emergency dilution flows, if needed) (see also Section 4.2.1.1 *[No Project] Alternative Description – Summary of Available Hydrology Information for the No Project Alternative)*, would result in an overall increase in flows under this alternative compared to existing conditions. While the additional flows would increase the mobility of existing surficial fine sediment deposits and infilled fine sediment from the armor layer, with potential for slight mobilization of the armor layer in some locations, new sediment supply would not occur and overall maintenance of static channel features would represent no change from existing adverse conditions for the Middle Klamath River between Iron Gate Dam and the confluence with the Scott River.

For reasons described for the No Project Alternative, there would be no other significant impacts of this alternative on geology and soils.

4.4.12 Historical Resources and Tribal Cultural Resources

Under the Continued Operations with Fish Passage Alternative, there would be no significant impacts to tribal cultural resources due to potential shifting and/or exposure of resources within the Lower Klamath Project reservoir footprints or located along the Klamath River (Potential Impacts 3.12-2, 3.12-3, 3.12-7), nor increased potential for looting (Potential Impacts 3.12-6, 3.12-8), since reservoir drawdown would not occur. The potential for impacts to tribal cultural resources due to wave erosion in the annual reservoir fluctuation zone would continue, as described under Potential Impacts 3.12-2 and 3.12-8 of the Proposed Project. Potential impacts to submerged historic-period archaeological resources (Potential Impacts 3.12-12 through 3.12-16) within the reservoir footprints and along the Klamath River also would not occur since the dams would not be removed and reservoir drawdown would not occur.

Salmonid habitat would increase due to fish passage installation under this alternative, and 2017 court-ordered flushing and emergency dilution flows would reduce the incidence of fish disease and parasites in the Klamath River, both of which would improve conditions for the Klamath Cultural Riverscape related to fisheries (Potential Impact 3.12-9) relative to existing conditions. This would be a beneficial effect.

Since only modest improvements in water quality would occur under this alternative, the ability of tribes to use the Middle and Lower Klamath River for ceremonial and other purposes would remain limited by existing, adverse conditions (Potential Impact 3.12-10). The Continued Operations with Fish Passage Alternative would continue to result in the same elevated concentrations of algal toxins in the water that commonly exceed public health advisory postings for water contact and inhibit the use of the Middle and Lower Klamath River for tribal purposes as under existing conditions (see also Potential Impact 3.12-10). As described under Potential Impact 4.2.2-7, there would be no change from existing adverse conditions related to algal toxins under this alternative, despite development and implementation of PacifiCorp's Reservoir Management Plan. Further, while nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial with respect to decreasing the prevalence of toxin-producing nuisance blue-green algal species such as *Microcystis aeruginosa*, it is anticipated that full attainment of the Oregon and California TMDLs would require decades to achieve. Warmer water temperatures under climate change would further exacerbate seasonal blooms of nuisance algal species in Copco No. 1 and Iron Gate reservoirs and overall there is currently no reasonable proposal to achieve water quality standards with the dams in place. Overall, the Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions with respect to Cultural Use of Klamath River waters without risk of adverse health effects (Potential Impact 3.12-10) and there would be no significant impact.

Under the Continued Operations with Fish Passage Alternative, construction activities to install fish ladders would occur at all four Lower Klamath Project dam complexes. Construction activities would result from the development of structures to support these fish passage options; however, the overall area of ground disturbance would be reduced as less structures would be removed. While construction-related impacts under this alternative would be less than those described for the Proposed Project, there would still be potential for construction-related impacts due to ground-disturbance, heavy equipment, and blasting such that Potential Impacts 3.12-1, 3.12-4, and 3.12-5 for tribal cultural resources and Potential Impacts 3.12-12, 3.12-15, and 3.12-16 for historic-period archaeological resources, would occur in the manner described for the Proposed Project. Implementation of Mitigation Measure TCR-1 (Tribal Resource Management Plan), including the specific terms one through seven thereunder enumerated, would reduce impacts to tribal cultural resources and historic-period archaeological resources from construction activities. It is not clear, however, whether the hydroelectric project owner or operator would implement these measures through good citizen agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced, outside of the measures required under the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act. Without an enforcement mechanism, these measures cannot be deemed feasible for the purposes of CEQA. Therefore, the aforementioned short-term construction-related impacts under the Continued Operations with Fish Passage Alternative would be significant and unavoidable.

4.4.13 Paleontologic Resources

The Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect paleontologic resources as compared to existing conditions (Section 3.13.2 *[Paleontologic Resources] Environmental Setting*).

4.4.14 Land Use and Planning

The Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect land use and planning and thus there would be no change from existing conditions (Section 3.14.2 *[Land Use and Planning] Environmental Setting*).

4.4.15 Agriculture and Forestry Resources

The Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect agriculture and forestry resources thus there would be no change from existing conditions Section 3.15.2 *[Agricultural and Forestry Resources] Environmental Setting*).

4.4.16 Population and Housing

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install fish ladders at all four Lower Klamath Project dam complexes. The estimated average construction workforce would be less than that of the Proposed Project (see Table 4.4-1 and Table 2.7-8) since the level of construction under this alternative would be less. Further, the process for constructing fish ladder facilities may occur over a period of four to eight years, which is a longer timeline as compared to that described for the Proposed Project, such that fewer construction workers may be present at any given time as compared with the Proposed Project. For construction of trap and haul facilities, the construction workforce would be even less. Although long-term employment to manage a trap and haul system would require more labor as compared to the fishway, the number of workers would be relatively small and overall the Continued Operations with Fish Passage Alternative would not result in a substantial influx of population (Potential Impact 3.16-1), nor would there be a need to displace existing residents or build replacement housing elsewhere (Potential Impact 3.16-2), for either short-term construction-related activities or long-term operational needs, and there would be no significant impacts.

4.4.17 Public Services

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. Construction activities required for fish passage facilities would be less than those necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project and would occur with less intensity since they may occur over a period of four to eight years. However, during periods of construction for this alternative, there would still be the potential for increased response times for emergency fire, police, and medical services due to construction-related traffic (Potential Impact 3.17-1), which may occur over a four-to eight-year period. This would be a significant impact. Implementation of Mitigation Measure HZ-1 (Section 3.21 *Hazards and Hazardous Materials*) would reduce this impact to less than significant for reasons described under the Proposed Project. Overseeing development and implementation of a Hazardous Materials Management Plan, as required under Mitigation Measure HZ-1 falls within the scope of the State Water Board's water quality certification authority. It is not clear, however, whether the hydroelectric project owner or operator would implement measures relating to traffic management (such as Recommended Measure TR-1), emergency response, and construction-related fire management through ‘good citizen’ agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced. Because the State Water Board cannot ensure implementation of these additional measures, it has determined that the construction-related impact on increased response times for emergency, fire, police, and medical services to be significant and unavoidable under this alternative.

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath Project reservoirs would remain in place and there would be no change from the existing condition in terms of the facilities’ availability to serve as a long-term water source for fighting wildfires. Therefore, there would be no impact (Potential Impact 3.17-2).

The Continued Operations with Fish Passage Alternative does not have the potential to affect schools in terms of additional students or longer bus routes, nor would it generate the need for additional classrooms or school services, and as identified under the Proposed Project (Potential Impact 3.17-3), would result in no significant impact.

4.4.18 Utilities and Service Systems

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. Construction activities required for fish passage facilities would be of a type similar to those described for the Proposed Project, but would be less than those necessary for removal of the Lower Klamath Project dam complexes and would occur with less intensity since they may occur over a period of four to eight years. However, during periods of construction for this alternative, there would still be the potential for impacts related to utilities and service systems, as described below.

The Continued Operations with Fish Passage Alternative would include the use of temporary wastewater treatment (i.e., portable chemical toilet facilities that are regularly cleaned, pumped, and have wastes disposed of by the toilet providers), stormwater drainage, and/or solid waste disposal facilities, albeit at a lower level than that described for the Proposed Project (Potential Impacts 3.18-1 through 3.18-4). Since the total area of construction-related activities for this alternative would amount to greater than one acre, the Proposed Project would be required to obtain coverage under the State Water Board Construction General Permit (2009-0009-DWQ as amended by 2010-0014-DWQ and 2012-0006-DWQ) (CGP). Each of the proposed construction areas, including staging, stockpiling, onsite disposal, and access-related areas, must be covered by the CGP. The CGP requires the applicant to address such items as employee wastewater generated during construction and spill containment and clean-up. Thus, meeting CGP requirements for onsite toilet facilities for short-term use by construction crews would not result in a significant impact as there would not be an increased need for permanent wastewater treatment facilities or an anticipated demand for additional wastewater treatment facilities.

Long-term employment to support operations of a trap and haul system would require relatively more labor as compared to that for fish ladders; however, overall the number of long-term workers would be relatively small and would not rise to the level that would affect utilities and service systems. Thus, this alternative would cause no change from existing conditions in the long term.

4.4.19 Aesthetics

Under the Continued Operations with Fish Passage Alternative, construction activities to install upstream and downstream fish ladders would occur at all four Lower Klamath Project dam complexes. This activity would take place within the Limits of Work for the Proposed Project. and would involve construction equipment, as well as use of staging areas and demolition areas. However, since construction of new infrastructure to support fish passage would occur near and potentially directly adjacent to the existing infrastructure (Potential Impact 3.19-5), the construction activities and the facilities themselves would not distract from a natural view relative to existing conditions in the short term or the long term and this alternative would result in a less than significant impact. No construction of new recreational facilities or improvements to existing recreational facilities would occur under this alternative. The level of overall construction is anticipated to be less under Continued Operations with Fish Passage Alternative than that described for the Proposed Project; thus the intensity and duration of the potential aesthetics impacts would also be less than those described for the Proposed Project and there would be no significant impact (Potential Impact 3.19-6). However, for reasons described for the Proposed Project, construction lighting would have significant and unavoidable impacts on nighttime views (Potential Impact 3.19-7). It is not clear whether the hydroelectric project owner or operator would implement measures to reduce nighttime light and glare on surrounding residences during construction. Overseeing development and implementation of measures to reduce impacts to nighttime views does not fall within the scope of the State Water Board's water quality certification authority. Without an enforcement mechanism, such measures cannot be deemed feasible for the purposes of CEQA. Therefore, the impact of this alternative on nighttime views would be significant and unavoidable during the period of construction activities.

The existing Lower Klamath Project dam complexes are already a part of the environmental baseline. Under the Continued Operations with Fish Passage Alternative, there would be no loss of open water vistas (Potential Impact 3.19-1), no significant changes in flows or channel morphology (Potential Impact 3.19-2), no changes in visual water quality due during periods of elevated SSCs (Potential Impact 3.19-3), and no exposure of bare areas of sediment and rock (Potential Impact 3.19-4), since the reservoirs would remain in place. Thus, this alternative would have no significant impact relative to existing conditions for these aspects of aesthetics. As the Continued Operations with Fish Passage Alternative does not include other physical or operational changes that would affect aesthetics in the long term, this determination also applies in the long term (5+ years).

4.4.20 Recreation

Unlike under the Proposed Project, reservoir-based recreation would continue under the Continued Operations with Fish Passage Alternative.

Under the Continued Operations with Fish Passage Alternative, construction activities would occur due to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. While construction activities required for fishway facilities would be less than those required for removal of the Lower Klamath Project dam complexes under the Proposed Project, they would still result in potential restrictions, noise, and dust. However, for reasons described for the Proposed Project, these impacts would be less than significant (Potential Impact 3.20-1). Although these impacts may be spread across a four- to eight-year period, no one site would be affected for that entire length of time and thus there still would be no significant impact compared with existing conditions. Facility construction and any related potential recreational impacts for trap and haul would be less than that described for fish ladders. Under this alternative, there would be no changes to or loss of local or regional reservoir-based recreation activities and facilities compared with existing conditions (Potential Impact 3.20-2 and 3.20-3), and no construction of new or expanded recreational facilities (Potential Impact 3.20-4) due to dam removal.

The Continued Operations with Fish Passage Alternative would increase minimum flows in the J.C. Boyle Bypass Reach and limit peaking operations at J.C. Boyle Powerhouse to one day per week. Since recreational flows in the Hydroelectric Reach would be limited under this alternative, the loss of whitewater boating opportunities in the Hell's Corner Reach[203] would be similar to those described for the Proposed Project (Potential Impact 3.20-5), except that the white water boating would be available one day per week. However, for the remaining six days per week during the late summer and early fall, when other regional alternative rafting opportunities are less available, see discussion in Potential Impact 3.20-5), this alternative would result in the loss of a unique opportunity in the region to raft Class IV+ rapids. This would affect up to 250 people per day during that time, as well as 10 commercial outfitters and would be a significant and unavoidable impact for the Hell's Corner Reach. There would be no significant impact in the Middle and Lower Klamath River since the effect of the altered river flows would be muted in California.

Under the Continued Operations with Fish Passage Alternative, construction of upstream and downstream fish passage at all Lower Klamath Project dams would benefit recreational fishing of anadromous fish throughout the Klamath River in California, including the Hydroelectric Reach, in a similar manner to that discussed under Potential Impact 3.20-6, although to a lesser degree. This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, however not to the degree expected under the Proposed Project. Overall, the Continued Operations with Fish Passage Alternative would have a beneficial effect on fishing for anadromous fish compared with existing conditions.

There would be no potential impacts on Wild and Scenic River resources, designations, or eligibility for listing due to construction of fish passage facilities (Potential Impact 3.20-7). In summary, with the exception of the loss of whitewater boating opportunities in the Hell's Corner Reach relative to existing conditions (which would be a significant and unavoidable impact), improvements in recreational fishing opportunities due to an increase in anadromous fish habitat (which would be a beneficial effect), and minor visual changes due to fish passage improvements (which would result in no significant impacts), scenery, recreation, fisheries, and wildlife conditions would remain consistent

[203] This reach is within the Hydroelectric Reach, extending approximately 16.4 river miles from J.C. Boyle Reservoir to Copco No. 1 Reservoir.

with existing conditions and there would be no short-term (0−5 years) or long-term (5+ years) impacts to recreational resources.

4.4.21 Hazards and Hazardous Materials

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. Construction activities required for fish passage facilities would be within the construction Limits of Work for the Proposed Project and would have similar potential for hazards and hazardous materials-related impacts as described in Section 3.21.5 *[Hazards and Hazardous Materials] Potential Impacts and Mitigation*. However, the level of construction under this alternative would be less than the level of construction necessary for removal of the Lower Klamath Project dam facilities under the Proposed Project and would result in less transport, use, and disposal of general construction waste materials (i.e., transport of waste materials from the removed dam facilities would not occur) and of hazardous materials from decommissioning of generation and transmission facilities (Potential Impacts 3.21-1, 3.21-2, and 3.21-4). For the reasons described under the Proposed Project, implementation of Mitigation Measure HZ-1 would result in no significant impacts.

The existing hazardous materials that have been identified at the Lower Klamath Project dam complexes would not be altered compared with existing conditions (Potential Impact 3.21-4). Therefore, there would be no significant impact.

For the reasons described under the Proposed Project, there would be no significant impacts due to hazards or hazardous materials in relation to schools (Potential Impact 3.21-3), public airports (Potential Impact 3.21-5), or private airstrips (Potential Impact 3.21-6).

Although the level of construction under this alternative would be less than the level of construction necessary for removal of the Lower Klamath Project dam facilities under the Proposed Project, this alternative could still result in short term impacts consisting of an increase in traffic on narrow rural roads from commuting workers, hauling of large equipment, and disposal of wastes. This additional traffic could interfere with emergency response vehicles as well as create a situation requiring an additional need for emergency response due to personal and vehicular accidents, natural and worksite-caused fires, and accidental releases of hazardous materials in the same manner as under the Proposed Project, though to a lesser degree (Potential Impact 3.21-7). This alternative could also result in an increased risk of wildland fires in the short term due to construction site activities (Potential Impact 3.21-8). It is not clear whether the hydroelectric project owner or operator would implement measures relating to traffic management, emergency response, and construction-related fire management through ‘good citizen’ agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced. Without an enforcement mechanism, these measures cannot be deemed feasible for the purposes of CEQA. Therefore, these impacts would be significant and unavoidable.

In the long term, there would be no impact related to the potential for longer response times and limitations on access to Klamath River water for fighting wildland fires under this alternative since the Lower Klamath Project reservoirs would not be removed (Potential Impact 3.21-8). This alternative would be the same as existing conditions. As the Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect other aspects of hazards and hazardous materials in the long term, there would be no significant long-term impact related to hazards and hazardous materials.

4.4.22 Transportation and Traffic

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. These construction activities would include the type of transportation and traffic impacts described for the Proposed Project (Potential Impacts 3.22.5-1 through 3.22.5-6). Although the level of construction under this alternative would be less than the level of construction necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project, this alternative could still result in an increase in traffic on narrow rural roads from commuting workers, hauling of large equipment, and disposal of wastes, particularly for fishway construction at Iron Gate Dam and Copco No. 1 dams, which would last for 12 months and 9 months, respectively (Table 4.4-1). For reasons described for the Proposed Project (Section 3.22 *[Traffic and Transportation] Potential Impacts and Mitigation*), this would be a significant impact compared with existing conditions. Implementation of measures such as those contained in the Traffic Management Plan and Emergency Management Plan proposed by the KRRC, as well as Recommended Measure TR-1, would be expected to reduce construction-related impacts to less than significant under this alternative. It is not clear, however, whether the hydroelectric project owner or operator would implement these measures through 'good citizen' agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced. Without an enforcement mechanism, these measures cannot be deemed feasible for the purposes of CEQA. Therefore, this alternative would result in significant and unavoidable traffic and transportation impacts.

Facility construction, and thus any related potential transportation and traffic impacts, for trap and haul would be less than that described for fish ladders. Long term trap and haul operations would consist of trapping adult upstream migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir as an ongoing activity. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Iron Gate Dam. Roads within the traffic and transportation Area of Analysis currently carry substantially fewer vehicles than the planning capacity (Table 3.22-2 and Section 3.22.2.1*Traffic Flow*), such that additional truck trips, assuming both upstream and downstream trap and haul operations, would not substantially change traffic conditions. Although the exact extent and timing of these ongoing hauling activities is not known, it is unlikely that more than ten truck trips per day would be necessary, including a conservative assumption of round trip (i.e., upstream and downstream) hauling for 60 to 70 miles each way between Iron Gate Dam and J.C. Boyle Reservoir. Therefore, trap and haul traffic would be a less than significant impact.

Significance
No significant impact

4.4.23 Noise

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. Construction activities would result in potential noise impacts in the same manner as described for the Proposed Project in Section 3.23.5 *[Noise] Potential Impacts and Mitigation*. Although the level of construction required for fish passage facilities would be less than construction required for removal of the Lower Klamath Project dam complexes, any use of dozers, jackhammers, and/or tractors would constitute an exceedance of the maximum allowable noise levels identified in the Siskiyou County General Plan Noise Element (Siskiyou County 1978) and would be a significant impact (Potential Impact 3.23-1). Implementation of a noise and vibration control plan such as that proposed by the KRRC (Appendix B: *Definite Plan – Appendix O5*) would reduce the short-term noise-related impacts from fish passage construction activities at Copco No. 1, Copco No. 2, and Iron Gate dams (Impacts 3.23-1 through 3.23-6). It is not clear, however, whether the hydroelectric project owner or operator would implement noise and vibration control measures through 'good citizen' agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced. Without an enforcement mechanism, the NVCP cannot be deemed feasible for the purposes of CEQA. Further, since any use of dozers, jackhammers, and/or tractors would constitute an exceedance of the maximum allowable County noise levels, noise-related impacts on sensitive receptors at Copco No. 1 and Iron Gate dams would remain significant and unavoidable (Potential Impact 3.23-1).

Due to the natural topography surrounding Copco No. 2 Dam and the distance between the dam and the closest receptor (see Potential Impact 3.23-3), noise from on-site construction activities at the Copco No. 2 Dam would be reduced by more than 65 dB (approximately 35 dB by the distance and an additional 30 dB due to the topography). This amount of noise and vibration reduction would reduce impacts on sensitive receptors such that there would not be a substantial increase and there would be no significant impact at sensitive receptors.

Activities associated with the implementation of seasonal trap and haul operation prescriptions for a new FERC license for the Continued Operations with Fish Passage Alternative could increase traffic noise on local roads. However, the number of trucks and travel frequency would be significantly less than during the construction phase of the project and there would be no significant traffic noise impact to sensitive receptors. If trap and haul is combined with an additional fishway prescription, such that it is used for either upstream or downstream fish passage from below Iron Gate Dam to above J.C. Boyle Dam, truck trips would be less and there also would be no substantial increase in noise and vibration on sensitive receptors and there would be no significant impact. Therefore, noise-related impacts due to traffic noise along haul routes (Potential Impact 3.23-7) would not result in a substantial increase of noise on sensitive receptors and would result in no significant impact.

Moving or elevating structures with flood risk and modification of downstream water intakes, and construction activities related to deepening or replacement of existing groundwater wells, would not occur under this alternative, and would therefore result in no noise change from the existing condition (Potential Impacts 3.23-8, 3.23-9, and 3.23-10, respectively).

4.5 Two Dam Removal Alternative

4.5.1 Introduction

4.5.1.1 Alternative Description

In the Two Dam Removal Alternative, Copco No. 1 and Iron Gate dams and associated facilities would be fully removed, and J.C. Boyle and Copco No. 2 dams and associated facilities would remain. The J.C. Boyle facilities that would remain include (see also Figure 2.3-1):

1. A 2,629-acre-feet reservoir (J.C. Boyle Reservoir);
2. A 68-foot tall earthfill dam (J.C. Boyle Dam), concrete spillway, and three spill gates;
3. A concrete intake structure connecting to a 2.5-mile water conveyance system with an overflow forebay;
4. A 98-megawatt (MW) J.C. Boyle Powerhouse;
5. A switchyard with 2.8 miles of transmission lines; and
6. Ancillary buildings including an office building (known as the Red Barn), maintenance shop, fire protection building, communications building, two occupied residences, and a warehouse.

The Copco No. 2 facilities that would remain include (see also Figure 2.3-3):

1. A 70-acre-feet reservoir (Copco No. 2 Reservoir);
2. A 32-foot tall concrete diversion dam (Copco No. 2 Dam) including a gated spillway, basin apron, end sill, and a remnant cofferdam upstream of the concrete dam below the normal water surface elevation of the reservoir;
3. An approximately 15,000-square foot earthen embankment section with a gunite cutoff wall along the river right sidewall;
4. A diversion water conveyance system consisting of 3,610 feet of concrete-lined, 16-foot diameter conveyance tunnel, 1,330 feet of a 16-foot diameter wooden-stave penstock, an underground surge tank, a 405.5-foot long, 16-foot diameter steel penstock, and a 410.6-foot long, 16-foot diameter steel penstock;
5. A 7,000-square foot, 27-MW Copco No. 2 Powerhouse;
6. A 1,900-square foot control center building;
7. A 4,500-square foot maintenance building;
8. A 650-square foot oil and gas storage building; and
9. The nearby mostly vacant Copco Village, with a total structure area of 32,200 square feet, consisting of a cookhouse, bunkhouse, storage building, bungalow, three modular houses, four old style ranch houses, and a schoolhouse/community center.

This alternative assumes that the J.C. Boyle and Copco No. 2 dams and associated facilities would be relicensed by FERC for continued operations with changes to allow for upstream and downstream fish passage and updated flow requirements. More specifically, the Two Dam Removal Alternative assumes conditions described in the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and*

Iron Gate Alternative[204] for J.C. Boyle Dam and Copco No. 2 Dam. The primary conditions under the Two Dam Removal Alternative are the following:

- *Fishway Prescriptions* – upstream and downstream fish passage at J.C. Boyle Dam and Copco No. 2 Dam consistent with the prescriptions from the DOI and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007) and upheld in a trial-type administrative hearing, and any specific fishway facility design and construction details included in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*[204], including fishway (i.e., fish passage structures installation for both upstream and downstream migrations and barriers to prevent entrainment into turbines);
- *Changes to J.C. Boyle Operations* – At least 40 percent of J.C. Boyle Reservoir inflow to be released downstream through the J.C. Boyle Bypass to increase minimum flows in the Bypass Reach (RM 225.2 to RM 229.8). J.C. Boyle hydroelectric peaking operations and/or recreation flows would not occur under the Two Dam Removal Alternative since Copco No. 1 and Iron Gate dams would not be present to reregulate flows downstream[205]. Power generation would be suspended and all inflow to J.C. Boyle Reservoir would be released down the Bypass Reach under a seasonal high flow event that would occur for seven full days in later winter/spring when inflows to J.C. Boyle first exceed 3,300 cfs (DOI 2007, NMFS 2007, FERC 2007); and
- *Changes to Copco No. 2 Operations* – Increase in minimum flows for the Copco No. 2 Bypass Reach (RM 200.0 to RM 201.5), with a release of 70 cfs or inflow, whichever is less, to the Bypass Reach. Inflow would be computed as a 3-day running average of flows at the J.C. Boyle Powerhouse gage added to the flow from Shovel Creek, as measured by a new gage (FERC 2007).

The following conditions under the Two Dam Removal Alternative are a modification to the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*:

- Flows specified in the NMFS and USFWS 2013 BiOp for the USBR Klamath Irrigation Project, which are currently being considered under reinitiated consultation (see also 3.1.6.1 *Klamath River Flows under the Klamath Irrigation Project's 2013 BiOp*).

As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing and emergency dilution flows are required to be released from Iron Gate Dam as part of re-initiation of consultation on the 2013 BiOp Flows, but they are not modeled as part of existing conditions hydrology. Potential new BiOp flow requirements under this alternative are speculative at this time, and it is not clear whether flushing and emergency dilution flow requirements would continue under the new BiOp during or after dam removal. However, the 2017 flow

[204] The KHSA 2012 EIS/EIR's *Section 2.4.5 Fish Passage at Four Dams Alternative* and *Section 2.4.6 Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative* (Appendix U) include fishway facility design and construction details beyond what are specifically required in the FERC prescriptions and that are based on designs of similar fishway facilities used at other hydroelectric facilities.

[205] Although it would remain in place under this alternative, Copco No. 2 Reservoir does not have adequate capacity to reregulate flows associated with J.C. Boyle Dam peaking operations so that they would be suitable for fish downstream.

requirements are considered to be the most reasonable assumption for conditions until agency formal consultation is completed and a new BiOp is issued. For analysis of potential impacts related to fish disease, the Two Dam Removal Alternative considers conditions with and without 2017 court-ordered flushing and emergency dilution flows.

Additionally, Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project* addresses the potential effects of using fishways other than the volitional ladders described in the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, and points out where such other fishways would result in different effects than fish ladders. Such fishway installation could include volitional facilities, or trap and haul facilities, or a combination of approaches. Regardless of how fish passage is provided, this alternative assumes fish passage consistent with the general prescriptions (DOI 2007) that cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007).

This alternative does not make any assumptions regarding conditions that could be imposed by the states of Oregon or California through water quality certification authority.

The aforementioned flow-related measures would reduce power generation at J.C. Boyle Dam. Power generation at Copco No. 2 Dam would decrease relative to existing conditions since Copco No. 1 would not be present upstream to regulate flows entering the Copco No. 2 Powerhouse. This alternative assumes that installation of fish passage facilities would follow the schedule described in *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*[206], which would install downstream passage facilities prior to upstream passage facilities and would take place over a 4-month period (June through September of dam removal year 2) for both J.C. Boyle Dam and Copco No. 2 Dam. The level of construction for J.C. Boyle and Copco No. 2 fish passage would be consistent with that estimated for development of the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative,* which includes removal of the existing J.C. Boyle fish ladder structure, construction of a new fishway at or near the same location as the existing fish ladder (Figure 2.3-1), and construction of downstream fish passage for J.C. Boyle Dam, as well as construction of upstream and downstream fish passage for Copco No. 2 Dam.

As neither the Fall Creek nor the Iron Gate hatchery facilities were built to address potential fisheries effects of J.C. Boyle Dam or Copco No. 2 Dam (Boyle 1976), this alternative assumes that hatchery operations would continue for eight years, with reduced production goals consistent with those described for the Proposed Project (see Section 2.7.6 *Hatchery Operations*).

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[206] Fishway feature design was provided in the 2012 KHSA EIS/EIR *Section 2.4.5 Fish Passage at Four Dams Alternative* and *Section 2.4.6 Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative* (Appendix U) and is used for this EIR to support the construction-related effects analysis. The KRRC would be required to obtain concurrence from USFWS and NMFS regarding fishway design and construction plans for each Lower Klamath Project facility prior to advancing to feasibility-level of design.

Although leaving the J.C. Boyle Dam facilities in place, removing the existing fish ladder and installing a new fish ladder, would be less construction than removing the dam and associated facilities, this difference would not decrease the degree of construction activities or the associated impacts to resources in California since J.C. Boyle is located in Oregon. In California, removal of the Iron Gate and Copco No. 1 facilities would be the same as described for the Proposed Project. California materials import for Copco No. 1 and Iron Gate would be the same as that described in Section 2.7.1 *Dam and Powerhouse Deconstruction* and California waste disposal quantities, truck trips, and haul distances would be the same as presented in Table 2.7-3 (Copco No. 1 Dam) and Table 2.7-7 (Iron Gate Dam). None of the deconstruction activities described in Section 2.7.1.3 *Copco No. 2 Dam and Powerhouse* would occur under this alternative, eliminating the need for offsite transport and disposal of the waste materials and quantities listed in Table 2.7-5 such that overall haul distances for waste disposal would be lower than those described for the Proposed Project. Additional import of construction materials in California would be required for fishway construction at Copco No. 2, which could include approximately 1,000 cubic yards of reinforced concrete (2012 KHSA EIS/EIR, Table 2-26) depending on the type of fish passage facilities that would be constructed. This amount of import would be considerably less than the bulk quantity of concrete that would be removed from Copco No. 2 Dam and Powerhouse under the Proposed Project (Table 2.7-5). Leaving Copco No. 2 Powerhouse and the wooden-stave penstock in place under this alternative would avoid the need for replacing Daggett Road Bridge (Appendix B: *Definite Plan – Section 5.4 Copco No. 2 Dam and Powerhouse*) and any associated materials import and waste disposal, and it would avoid the need to dispose of 700 tons of treated wood (Table 2.7-5). Recreation facilities near J.C. Boyle Reservoir would remain intact, and the Copco No. 2 Reservoir does not have any developed recreation facilities. Recreation facilities at Iron Gate and Copco No. 1 reservoirs would be removed, as described under the Proposed Project (Section 2.7.8.3 *Recreation Facilities Management*).

Overall, under the Two Dam Removal Alternative the level of construction activities in California in the Hydroelectric Reach due to dam deconstruction at Copco No. 1 and Iron Gate facilities, and construction of upstream and downstream fish passage at Copco No. 2 Dam would be slightly less than those described under the Proposed Project, since full removal of the two largest dam facilities (Copco No. 1 and Iron Gate) would still occur. Workforce projections under the Two Dam Removal Alternative are presented in Table 4.5-1. Since construction activities for fish passage would occur at J.C. Boyle Dam and Copco No. 2 Dam concurrent with activities for removal of the Copco No. 1 and Iron Gate dams and associated facilities (i.e., for a 4-month period June through September of dam removal year 2), any construction-related impacts would also occur concurrently and some of these (e.g., water quality) that occur in Oregon could also result in downstream impacts in California.

Table 4.5-1. Estimated Construction Workforce for the Two Dam Removal Alternative.

Dam	Estimated Average Construction Workforce[a]	Duration	Estimated Peak Workforce	Peak Period
J.C. Boyle*	10 to 15 people[a]	4 to 6 months[a]	15-20 people[a]	Jun−Sep dam removal year 2[b]
Copco No. 1	35 people[b]	12 months[b]	55 people[b]	Apr–Nov dam removal year 2[b]
Copco No. 2	10 to 15 people[a]	4 to 6 months[a]	15-20 people[a]	Apr−Sept dam removal year 2[b]
Iron Gate	40 people[b]	10 months[b]	80 people[b]	Jun−Sep dam removal year 2[b]

* J.C. Boyle Dam is included in this table as some of the traffic flow may use roads in California (e.g., I-5 to OR 66)
[a] 2012 KHSA EIS/EIR
[b] Appendix B: *Definite Plan – Section 5*

If instead of fish ladders, trap and haul or some combination of fish passage methods were used, there would be the potential for reduced construction compared to the aforementioned activities for fish ladders. While trap and haul facilities differ by site, common features include a trap holding pool, diffusers or gates to guide fish into the trap, a channel or port for discharge of attraction flows, a lift mechanism for truck-loading fish, a truck loading station, and a discharge platform. Much of the trap and haul facility would be located in-stream, with only the truck loading station and discharge platform potentially requiring upland grading or other earthwork.

As described for the Proposed Project (Section 2.7.2 *Reservoir Drawdown*), power generation at Copco No. 2 Dam could continue to occur during removal of the other Lower Klamath Project dams and associated facilities if Copco No. 2 power generating equipment proves capable of operating under sediment-laden flow conditions. However, high suspended sediment concentrations (SSCs) that would occur during drawdown of the upstream J.C. Boyle and Copco No. 1 reservoirs could damage the turbines in Copco No. 2 Powerhouse such that they would require repair to support future operations. This EIR assumes continued powerhouse operations at Copco No. 2 during dam removal year 2 as described for the Proposed Project (see Section 2.7.2 *Reservoir Drawdown*) as the need to halt power generation is speculative. Water diversions for hydropower generation at Copco No. 2 would continue to affect flows in the 1.5-mile-long Bypass Reach in the Klamath River between the Copco No. 2 Dam and the Copco No. 2 Powerhouse (Figure 2.3-3) under this alternative.

Under the Two Dam Removal Alternative, the long-term use of the land currently underlying Iron Gate and Copco No. 1 reservoirs is more uncertain than under the Proposed Project, because the KHSA (including Section 7.6.4 that addresses land disposition) would not apply. It is possible that the hydroelectric license holder would reach an agreement to transfer the lands in and surrounding the Copco No. 1 and Iron Gate reservoirs for public interest purposes, in a manner similar to under the KHSA. If this were to happen, the potential impacts would be as analyzed under the Proposed Project, except that the land associated with Copco No. 2 facilities would not be made available.

It is also possible that the dams would remain undeveloped and under the Licensed hydroelectric facility operator, in light of continued operations in the area, or that they would be used for additional revenue generation, such as for lease or additional residential, commercial, or industrial development. It is also possible that a combination of these two scenarios would occur.

Because long-term land use under this alternative is currently unknown, this alternative does not assess the potential impacts of long-term use of the lands currently submerged under Iron Gate and Copco No. 1 reservoirs as that would require speculation.

4.5.1.2 Alternative Analysis Approach

The potential impacts of the Two Dam Removal Alternative are analyzed in comparison to existing conditions, with reference to impact analyses conducted for the No Project Alternative or Proposed Project, where appropriate. Unless otherwise indicated, the significance criteria, area of analysis, environmental setting, and impact analysis approach, including consideration of existing local policies, for all environmental resource areas under the Two Dam Removal Alternative are the same as those described for the Proposed Project (see Section 3.1 *Introduction* and individual resource area subsections in Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures*). The potential impacts for each environmental resource area are analyzed both in the short term and the long term, and unless otherwise indicated, use the same definitions of short term and long term as described for each resource area analyzed for the Proposed Project.

4.5.2 Water Quality

Water quality modeling specifically for the Two Dam Removal Alternative is limited compared to the available modeling for the Proposed Project or the No Project Alternative, but the influence of J.C. Boyle and Copco No. 2 dams and the effects of J.C. Boyle and Copco No. 2 dams remaining in place can be assessed through a combination of modeling scenarios equivalent to the Two Dam Removal Alternative or interpretation of the modeling done for the Proposed Project or other alternatives. Water quality models and modeling scenarios for evaluating the impacts of the Two Dam Removal Alternative are summarized in Appendix D. An analysis of model results from different reaches within the Klamath River highlights how J.C. Boyle and Copco No. 2 dams remaining in place would impact water quality. The influence of J.C. Boyle Dam on water quality can be assessed by the Klamath River Water Quality Model (KRWQM) and the River Basin Model 10 (RBM10), which both include modeling scenarios that have J.C. Boyle Dam remaining in place and Copco No. 1, Copco No. 2, and Iron Gate dams removed. The Klamath TMDL model includes a “TMDL dams-in” scenario (T4BSRN), which approximates the condition where the Lower Klamath Project dams remain in place, as well as the TOD2RN (Oregon reaches) and TCD2RN (California reaches) scenarios (together the “TMDL dams-out” scenario) that assume the removal of the Lower Klamath Project (see Appendix D for more detail). The Klamath TMDL model assumes full TMDL implementation for both “TMDL dams-in” and “TMDL dams-out” scenarios. While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*). Comparison of “TMDL dams-in” and “TMDL dams-out" model results and comparisons of Proposed Project model results at different points in the Hydroelectric Reach (SRH-1D) also documents the influence of J.C. Boyle Dam. Models and modeling scenarios generally did not represent Copco No. 2 Dam due to its small size and short distance downstream of Copco No. 1 Dam. The influence of Copco No. 2 Dam and how its presence or absence would impact water quality in the Klamath River is determined by assessing the size, average water velocity, and hydraulic residence time of Copco No. 2 Reservoir compared to process(es) influencing the water quality parameters (e.g., settling velocity for suspended sediments). Overall, the available water quality modeling results provide sufficient information that the water quality impacts under the Two Dam Removal Alternative can be quantitatively or qualitatively assessed below.

4.5.2.1 Water Temperature

In general, the Two Dam Removal Alternative would have the same or similar potential impacts on water temperature in California as those identified under the Proposed Project. The presence of the J.C. Boyle Reservoir on the Klamath River does not alter water temperatures in downstream reaches because it has a shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days) that does not support thermal stratification (FERC 2007). However, J.C. Boyle Dam operations do influence Klamath River water temperatures by releasing water for peaking power generation and whitewater recreation. These releases cause water temperature variations in the J.C. Boyle Bypass and Peaking reaches, from the Oregon-California state line to Copco No. 1 Reservoir, due to diversion of warmer reservoir discharges around the J.C. Boyle Bypass Reach, cold groundwater spring flows into the J.C. Boyle Bypass Reach, and the mixing of these flows when they rejoin in the J.C. Boyle Peaking Reach of the Klamath River. The combination of these flows produce an observed increase in daily water temperature range above the natural diel water temperature fluctuations in the J.C. Boyle Peaking Reach at the Oregon-California state line.

The Two Dam Removal Alternative would not include peaking power generation or whitewater recreation flows from J.C. Boyle Dam as the downstream dams would not be available to regulate the peaking flows. Elimination of the peaking and recreation flows from J.C. Boyle Dam would likely result in J.C. Boyle Reservoir operating in a run of the river manner and increases in the water temperature range associated with J.C. Boyle operations would no longer occur under both the Two Dam Removal Alternative and the Proposed Project (see also Section 3.2.2.2 *Water Temperature*).

Model results analyzed for the Proposed Project do not explicitly isolate the effects of the four individual Lower Klamath Project reservoirs on water temperature, but the KRWQM includes a scenario in which only Iron Gate and Copco No. 1[207] dams are removed with J.C. Boyle Dam and Copco No. 2 remaining in place ("WIGC" PacifiCorp 2004a; Dunsmoor and Huntington 2006; see also Appendix D). While the KRWQM WIGC scenario does not document the water temperature effect of Copco No. 2 Dam remaining in place, it does show the effect of J.C. Boyle Dam remaining in place. The KRWQM WIGC scenario results indicate that compared with removal of all four Lower Klamath Project reservoirs ("WIGCJCB"), the long-term effects of keeping J.C. Boyle

[207] Copco No. 2 dam was not explicitly included in the model due to its negligible size and hydraulic residence time.

Dam and Copco No. 2 in place under the Two Dam Removal Alternative would be similar to effects on water temperature under the Proposed Project (Figure 4.5-1).

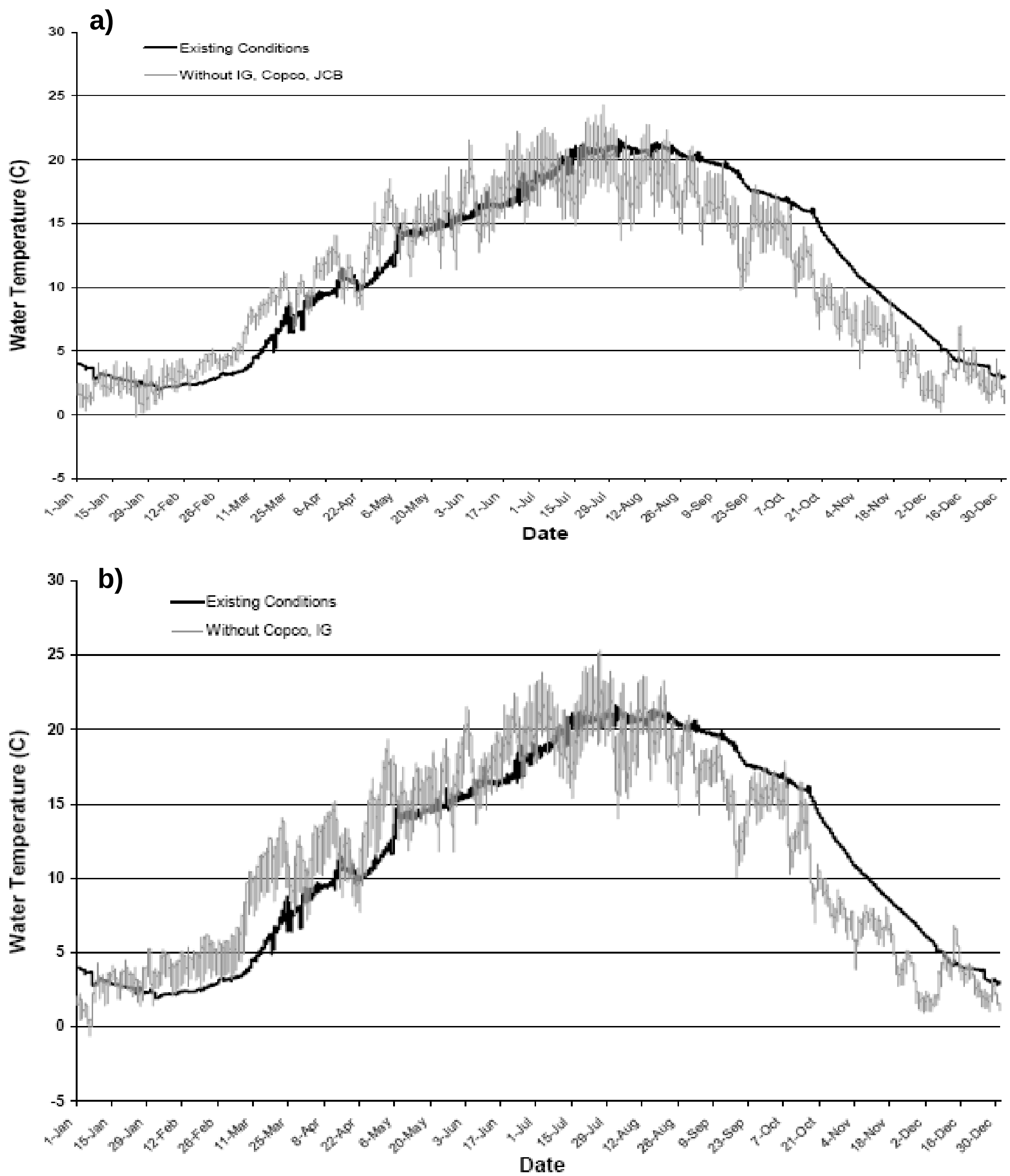

Figure 4.5-1. Simulated Hourly Water Temperature Downstream from Iron Gate Dam Based on Year 2004 for Current Conditions Compared to Hypothetical Conditions: (a) without Iron Gate (IG), Copco No. 1 and 2, and J.C. Boyle (JCB) Dams and (b) without Iron Gate (IG) and Copco No. 1 and 2 Dams. Source: PacifiCorp 2005.

Copco No. 2 Reservoir has a small volume (approximately 70 acre-feet), a short hydraulic residence time (less than a day), no active storage, and it does not thermally stratify, such that the reservoir has a negligible impact on water temperature, unlike the larger Copco No. 1 and Iron Gate reservoirs (see 3.2.2.1 *Overview of Water Quality Processes in the Klamath Basin*; FERC 2007; USBR 2012). Copco No. 2 Reservoir and Dam typically are not represented in modeling of the Klamath River as it is considered to have a negligible influence on water quality, including water temperature, in the Klamath River due to its small size, short hydraulic residence time, and lack of active storage. There is no data indicating Copco No. 2 Reservoir alters water temperatures in downstream reaches. As such, keeping Copco No. 2 Dam and Reservoir in place under the Two Dam Removal Alternative would not be anticipated to alter water temperature.

Relative to existing conditions, the potential impacts of the Two Dam Removal Alternative on water temperature would be the same as or similar to those described for the Proposed Project, except as follows:

- J.C. Boyle Reservoir would not alter water temperature in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir and J.C. Boyle Dam operations for peaking and recreation releases that cause increases in the water temperature range would be eliminated under both the Two Dam Removal Alternative and the Proposed Project. Short-term and long-term alterations in water temperatures in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir under the Two Dam Removal Alternative would result in water temperature effects similar to those of the Proposed Project (i.e., slightly lower maximum water temperatures and less artificial diel temperature variation during summer and early fall, see also Potential Impact 3.2-1) and would be beneficial.
- Short-term and long-term alterations in water temperatures due to conversion of the Copco No. 1 and Iron Gate reservoir areas to a free-flowing river (Potential Impact 3.2-1) and keeping Copco No. 2 Reservoir in place would be the same as under the Proposed Project as retaining Copco No. 2 Reservoir would not alter water temperature in the Klamath River, and the alterations would be beneficial for the Hydroelectric Reach and the Middle Klamath River to the confluence with the Salmon River. As under the Proposed Project, there would be no significant impact for the Middle Klamath River downstream from the Salmon River, the Lower Klamath River, or the Klamath River Estuary.
- Sediment trapped by J.C. Boyle Dam would not be released under the Two Dam Removal Alternative, but the magnitude of the sediment releases from Copco No. 1 and Iron Gate reservoirs would still be over 90 percent of the sediment releases under the Proposed Project (Table 2.7-11). Copco No. 2 Reservoir would not retain the sediment released from Copco No. 1 due to its short residence time and the sediment characteristics (see Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown* and Section 4.5.2.2 *Suspended Sediments*). Thus, the overall short-term and long-term alterations in seasonal water temperatures in the Klamath River due to potential morphological changes induced by sediment release from Copco No. 1 and Iron Gate reservoirs and subsequent deposition would be similar under the Two Dam Removal Alternative and the Proposed Project (Potential Impact 3.2-2), and there would be no significant impact.

4.5.2.2 Suspended Sediments

As the Two Dam Removal Alternative does not include the removal of J.C. Boyle and Copco No. 2 dams, short-term mobilization of J.C. Boyle reservoir sediment deposits would not occur under this alternative and the associated 1,190,000 cubic yards of deposits estimated to occur in the reservoir in 2020[208] (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-10 and 2.7-11) would not be eroded or delivered to downstream reaches and the Pacific Ocean. The approximately 27 to 51 percent of the sediment trapped behind the J.C. Boyle Dam predicted to move downstream through the California reaches of the Klamath River and out into the Pacific Ocean under the Proposed Project (USBR 2012) would not be transported under the Two Dam Removal Alternative. Copco No. 2 Dam also does not retain appreciable amounts of sediment (USBR 2011b) since Copco No. 1 Dam is 0.25 miles upstream and intercepts and retains all upstream sediment. As such, the variation in the amount of sediment transported under the Two Dam Removal Alternative compared to under the Proposed Project would be due to only the decrease from J.C. Boyle reservoir sediment deposited being retained.

Copco No. 1 and Iron Gate reservoirs contain approximately 92 percent of the total estimated 2020 reservoir deposits (50 and 42 percent, respectively) and approximately 92 to 94 percent of the amount of sediment anticipated to erode from these reservoirs under the Proposed Project (Table 2.7-11) would occur under the Two Dam Removal Alternative. Increases in suspended sediment concentrations (SSCs) in the Hydroelectric Reach upstream of Copco No. 1 Reservoir from removal of J.C. Boyle Reservoir would be eliminated under this alternative as reservoir sediment would not be released from J.C. Boyle Reservoir. While there would be some reduction in SSCs downstream of Copco No. 1 due to no SSCs being released by J.C. Boyle Dam removal, Copco No. 2 Dam is unlikely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*), such that leaving it in place would not result in a difference in short-term mobilization of reservoir sediment deposits or SSCs under the Two Dam Removal Alternative compared to the Proposed Project.

Modeling of SSCs downstream of Copco No. 1 Reservoir from release of only Copco No. 1 Reservoir sediment deposits across the wet, average, and dry water year types indicate SSCs, within the general uncertainty of the model, would peak at approximately 7,000 to 8,000 mg/L between Copco No. 1 Dam and Iron Gate Reservoir within one to two months of reservoir drawdown, then SSCs would decrease to generally less than 1,000 mg/L within approximately one more month (Figure 3.2-15; see Section 3.2.5.2 *Suspended Sediments*). Thus, SSCs in the Hydroelectric Reach between Copco No. 1 and Iron Gate reservoirs would still exceed the significance criteria for suspended sediment (SSCs greater than 100 mg/L over a continuous two-week exposure period) under the Two Dam Removal Alternative due to the overall magnitude of reservoir deposits still anticipated to erode from Copco No. 1 and Iron Gate reservoirs. Downstream of the Hydroelectric Reach, SSCs would also exceed the significance criteria for suspended sediment under the Two Dam Removal Alternative since over 90 percent of the reservoir deposited sediments anticipated to be transported under the

[208] Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable.

Proposed Project would still occur. Thus, the overall short-term impact of decreases in SSCs in the Hydroelectric Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir due to J.C. Boyle Dam remaining in place, no change in SSCs from Copco No. 2 Dam remaining in place, and increases in SSCs due release of sediments currently trapped behind Copco No. 1 and Iron Gate dams under the Two Dam Removal Alternative would be similar to impacts under the Proposed Project in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, the Klamath River Estuary, or the nearshore marine environment. (see Section 3.2.5.2 *Suspended Sediments* for additional details).

Sediments and suspended materials (inorganic and organic) would continue to be intercepted and retained behind J.C. Boyle Dam in the long term under the Two Dam Removal Alternative since that dam would remain in place. While the amount of sediment supplied to the Klamath River on an annual basis from the watershed upstream of J.C. Boyle Dam is a relatively small fraction of the total sediment (Stillwater Sciences 2010) (see also Section 3.11.2.4 *Sediment Load*), the long-term increase in mineral (inorganic) suspended material downstream of J.C. Boyle Dam under this alternative would be less than under the Proposed Project since J.C. Boyle Dam would continue to intercept upstream sediment. The majority of algal-derived (organic) suspended material from upstream sources (Upper Klamath Lake, Klamath Straights Drain, Lost River) is intercepted and retained by the Keno Impoundment/Lake Ewauna, but J.C. Boyle Dam does retain some algal-derived (organic) suspended material (see Appendix C, Section C.2.1 *Upper Klamath Basin* for more detail). Thus, the long-term increases in algal-derived (organic) suspended material downstream of J.C. Boyle Dam under this alternative would be less than under the Proposed Project since the dam would continue to intercept and retain upstream algal-derived suspended material.

Long-term interception and retention of sediments and suspended materials (inorganic and organic) would be minimal behind Copco No. 2 Dam[209] due to its small size and short residence time. Fine sediment and suspended material would be unlikely to accumulate behind Copco No. 2 Dam because the range of flow and water velocities along with the short residence time in Copco No. 2 Reservoir would inhibit appreciable amounts of fine sediment and suspended material from settling within the reservoir. However, some larger sediment (i.e., sand) that can settle out faster may accumulate over time behind Copco No. 2 Dam, but the overall interception and retention would be limited since J.C. Boyle Dam upstream would intercept and retain larger sediment from upstream of that dam. The sediment load in the Hydroelectric Reach from J.C. Boyle Dam to Copco No. 2 Dam is relatively small compared to upstream of J.C. Boyle Dam, and higher winter flows in Copco No. 2 Reservoir under the Two Dam Removal Alternative would be likely to mobilize desposited sand sediments. Thus, the long-term inteception and retention in sediments and suspended materials (inorganic and organic) behind Copco No. 2 Dam under this alternative would be minimal and the overall long-term inteception and retention in sediments and suspended materials would be similar to conditions under the Proposed Project.

Long-term interception and retention of sediments and suspended materials (inorganic and organic) would not occur behind Copco No. 1 and Iron Gate dams since they would be removed under the Two Dam Removal Alternative. Long-term increases in mineral

[209] Copco No. 2 Dam does not intercept or retain appreciable amounts of sediment (USBR 2011b).

(inorganic) and algal-derived (organic) suspended material under this alternative would be less than under the Proposed Project because J.C. Boyle Dam would continue to retain sediments and suspended materials from upstream of that dam. However, the overall long-term impact from changes in the interception of sediments due to retention of J.C. Boyle and Copco No. 2 dams and removal of Copco No. 1 and Iron Gate dams would be similar under both the Two Dam Removal Alternative and the Proposed Project. The long-term increases in mineral (inorganic) and algal-derived (organic) suspended material due to the lack of interception by the dams would be a less than significant impact under the Proposed Project as only a small amount of sediment and suspended material is delivered from upstream of J.C. Boyle Dam. Thus, a decrease in the amount of sediment transported downstream under the Two Dam Alternative due to the retention of J.C. Boyle and Copco No. 2 dams and removal of Copco No. 1 and Iron Gate dams would still be a less than significant impact.

Relative to existing conditions, the potential impacts of the Two Dam Removal Alternative on suspended sediments would be the same as or similar to those described for the Proposed Project, except as follows:

- As discussed in the first two paragraphs of this section, there would be no change in SSCs from the existing conditions in the Hydroelectric Reach between the Oregon-California state line and the upstream end of Copco No. 1 Reservoir since sediment deposits in J.C. Boyle Dam would remain in place. While Copco No. 2 remaining in place would not retain appreciable amount of sediments or alter SSCs during drawdown, the increases in suspended sediment in the Hydroelectric Reach due to release of sediments currently trapped behind Copco No. 1 and Iron Gate Dams would remain a short-term significant and unavoidable impact for the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary (Potential Impact 3.2-3). The magnitude of suspended sediments increases in the Pacific Ocean nearshore environment due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams would be within the range of historical conditions, but the duration (i.e., weeks) of elevated suspended sediments would be greater than historical conditions, thus there would be a short-term significant and unavoidable impact on suspended sediments in the Pacific Ocean nearshore environment (Potential Impact 3.2-3). Suspended sediments would resume modeled background levels by the end of Post-Dam removal year 1, so there would be no significant impact in the long term for the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment (Potential Impact 3.2-3). The short-term significant impact of increased SSCs in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment due to removal of Copco No. 1 and Iron Gate dams cannot be avoided or substantially decreased through reasonably feasible mitigation.
- While there would not be potential construction-related short-term increases in suspended material from removal of J.C. Boyle Dam under the Two Dam Removal Alternative, there would be construction of new fish passage facilities at J.C. Boyle Dam that would potentially result short-term increases in suspended material downstream in California. Although short-term dam deconstruction activities would not occur at Copco No. 2 Dam under the Two Dam Removal Alternative, construction of upstream and downstream fish passage facilities and a new day use area near Copco No. 2 Dam would occur. As such, the level of overall

construction activities in the Hydroelectric Reach in California would be slightly less than under the Proposed Project. Potential construction-related short-term increases in suspended material from pre-construction, dam removal, and restoration activities at Copco No. 1 and Iron Gate dams would be the same under this alternative as under the Proposed Project since these activities would occur in both scenarios. Under the Two Dam Removal Alternative, short-term increases in suspended material from stormwater runoff due construction activities associated with new fish passage facilities at J.C. Boyle and Copco No. 2 dams, a new day use area near Copco No. 2 Dam, and pre-construction, dam removal, and restoration activities at Copco No. 1 and Iron Gate dams would be potentially significant short-term impacts without mitigation in the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam and in the Middle Klamath River immediately downstream of Iron Gate Dam (Potential Impact 3.2-4). Implementation of mitigation measures WQ-1, TER-1, and HZ-1 would reduce this potential impact under the Two Dam Removal Alternative to no significant impact with mitigation, similar to the Proposed Project.

- As discussed earlier in this section, there would be no long-term change from existing conditions regarding the interception and retention of mineral (inorganic) (Potential Impact 3.2-5) or algal-derived (organic) (Potential Impact 3.2-6) suspended material by J.C. Boyle Dam in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir under the Two Dam Removal Alternative because J.C. Boyle Dam would remain in place and continue to intercept and retain mineral and algal-derived suspended material to the same extent that it currently does. Similar to under the Proposed Project, there would be potential long-term increases in suspended material in the Hydroelectric Reach downstream of Copco No. 1 Reservoir because Copco No. 1, and Iron Gate dams would be removed under this alternative and they would no longer intercept and retain suspended material. Copco No. 2 Dam remaining in place under this alternative would not alter the long-term change in sediments and suspended materials (inorganic and organic) compared to the Proposed Project because the small size and short residence time of Copco No. 2 Reservoir would limit the trapping of sediment and suspended material (inorganic and organic). Overall, keeping J.C. Boyle and Copco No. 2 dams in place and removing of Copco No. 1 and Iron Gate dams would result in a long-term increase in suspended material under the Two Dam Removal Alternative similar to the Proposed Project due to the lack of continued interception and retention of mineral (inorganic) and algal-derived (organic) downstream of Copco No. 1 Dam and there would be no significant impact for the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam, the Middle Klamath River, Lower Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environment (Potential Impacts 3.2-5 and 3.2-6).

4.5.2.3 Nutrients

Short-term or long-term increases in sediment-associated nutrients due to release of J.C. Boyle reservoir sediment deposits would not occur in the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir under the Two Dam Removal Alternative because none of the associated 1,190,000 cubic yards of deposits estimated to occur in the reservoir in 2020[210] (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches. As detailed in Section 4.5.2.2 *Suspended Sediments*, approximately 27 to 51 percent of the sediment trapped behind the J.C. Boyle Dam is predicted to be transported under the Proposed Project (USBR 2012), but this would not occur under the Two Dam Removal Alternative. Thus, nutrients associated with these sediments also would not be transported downstream and there would be no increase in sediment-associated nutrients from existing conditions in the Hydroelectric Reach between the Oregon-California state line and the upstream end of Copco No. 1 Reservoir.

Approximately 92 to 94 percent of the sediment anticipated to erode from Copco No. 1 and Iron Gate reservoirs under the Proposed Project (Table 2.7-11) would occur under the Two Dam Removal Alternative and mobilization of nutrients associated with these reservoir sediment deposits would occur. The majority of sediment-associated nutrients would be transported under both this alternative and the Proposed Project, but sediment-associated nutrients downstream of Copco No. 1 Dam would be slightly less under the Two Dam Removal Alternative than under the Proposed Project because nutrients associated with J.C. Boyle reservoir sediments would not contribute to nutrient concentrations. Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b) under existing conditions and it is not expected to trap appreciable amounts of sediment during drawdown, so keeping Copco No. 2 in place under the Two Dam Removal Alternative would not alter the amount of sediment-associated nutrients transported downstream compared to under the Proposed Project. Thus, the overall pattern and duration of short-term and long-term increases in sediment-associated nutrients due to release of sediments from behind the Copco No. 1 and Iron Gate dams under the Two Dam Removal Alternative would be similar to the Proposed Project in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, or the nearshore marine environment, but the magnitude of nutrient concentrations would be slightly less. See Section 3.2.5.3 *Nutrients* for further details.

Since J.C. Boyle Dam would remain in place, continuing interception and retention of sediment-associated nutrients and suspended materials would still occur behind J.C. Boyle Dam in the long term. However, Klamath TMDL modeling[211] and empirical data indicate that J.C. Boyle Dam does not retain high amounts of nutrients such that long-term effects of dam removal on nutrient levels in the Hydroelectric Reach under the Proposed Project would be primarily due to the removal of Copco No. 1 and Iron Gate dams (see generally Section 3.2.2.4 *Nutrients* and Section 3.2.5.3 *Nutrients* for information on the existing conditions for nutrients in the reservoirs). Under existing conditions, Klamath TMDL modeling[211] indicates interception results in Copco No. 1

[210] Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable.

[211] While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*).

retaining approximately 10.0 percent of the annual total nitrogen and approximately 5.1 percent of the annual total phosphorus; and Iron Gate retaining approximately 6.7 percent of the annual total nitrogen and approximately 3.3 percent of the annual total phosphorus (North Coast Regional Board 2010). The relative amounts of nutrient retention in each of the reservoirs without full TMDL implementation may be somewhat higher than the aforementioned estimates because the model mechanism increases the rate of retention as incoming nutrient concentrations increase; however, the model mechanism also indicates that the longer the retention time of water in the reservoir, the higher the nutrient retention. Copco No. 1 and Iron Gate reservoirs have average retention times of 11 days and 15 days, respectively, while J.C. Boyle Reservoir has a lower retention time of only approximately 1 day (Table 3.6-4) and thus allows most sediment-associated nutrients to pass through J.C. Boyle Reservoir and move downstream. Under the Two Dam Removal Alternative, long-term interception and retention of sediments and sediment-associated nutrients behind Copco No. 1 and Iron Gate dams would cease, similar to the Proposed Project, as the facilities would be removed. While Copco No. 2 Dam may retain some larger sediment (i.e., sand or larger), nutrients are not associated with such larger sediments and Copco No. 2 Dam is not anticipated to retain appreciable amount of fine sediment that have sediment-associated nutrients after removal of Copco No. 1 and Iron Gate dams. Thus, Copco No. 2 Dam staying in place under the Two Dam Removal Alternative would not alter long-term transport of sediment-associated nutrients compared to the Proposed Project.

Relative to existing conditions, the potential impacts of the Two Dam Removal Alternative on nutrients would be the same as or similar to those described for the Proposed Project, except as follows:

- There would be no short-term or long-term change to the existing condition with regard to sediment-associated nutrients in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir, since sediment deposits in J.C. Boyle Dam would remain in place and no sediment-associated nutrients would be transported due to the release of sediments trapped behind J.C. Boyle Dam. Copco No. 2 Dam does not retain appreciable amounts of sediments or sediment-associated nutrients under existing conditions, so keeping Copco No. 2 in place under the Two Dam Removal Alternative would not alter the amount of sediment-associated nutrients transported downstream compared to under the Proposed Project. However, there would be short-term increases in sediment-associated nutrients due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams as in the Proposed Project (Potential Impact 3.2-7). Potential short-term increases in suspended material from construction of a new fish ladder at J.C. Boyle would be not result in short-term increases in sediment-associated nutrients since potential construction sediments would only have the nutrient content of the soils surrounding J.C. Boyle with substantially less nutrients than reservoir sediment deposits. As described in Section 3.2.5.3 *Nutrients*, this would result in no significant impact in the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam, the Middle Klamath River, the Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment.
- Under the Two Dam Removal Alternative, there would be no long-term change from existing nutrient levels due to interception of nutrients by J.C. Boyle Dam in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir since J.C. Boyle Dam would remain in place.

Copco No. 1 and Iron Gate dams would be removed and replaced by a free-flowing river under this alternative like in the Proposed Project, so these dams would no longer intercept and retain incoming nutrients. Copco No. 2 Dam would not retain appreciable amounts of sediments with sediment-associated nutrients, so keeping Copco No. 2 Dam in place would not alter the long-term nutrients levels compared to the Proposed Project. Long-term increases in nutrient levels from the lack of continued interception by the Copco No. 1 and Iron Gate dams and conversion of the reservoir areas to a free-flowing river (Potential Impact 3.2-8) would result in no significant impact under the Two Dam Removal Alternative for the Hydroelectric Reach, Middle and Lower Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environment, similar to the Proposed Project.

4.5.2.4 Dissolved Oxygen

J.C. Boyle reservoir sediment deposits (approximately 1,190,000 cubic yards in 2020 or approximately eight percent of total sediment volume trapped behind the Lower Klamath Project dams, see also Tables 2.7-7 and 2.7-8) would be not mobilized in the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir under the Two Dam Removal Alternative since J.C. Boyle Dam would remain in place (see Section 4.5.2.2 *Suspended Sediments*). Thus, the short-term mobilization associated effects of these sediments on sediment-associated oxygen demand and dissolved oxygen (i.e., high content of organic carbon present in the reservoir sediments allows for the possibility of microbial oxidation of organic matter exposed to the water column from deep within the sediment profile and mobilized during dam removal), would also not occur in the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir under the Two Dam Removal Alternative. However, approximately 92 to 94 percent the reservoir sediment deposits anticipated to erode under the Proposed Project would still occur in this alternative due to transport of reservoir sediments from Copco No. 1 and Iron Gate reservoirs (see Section 4.5.2.2 *Suspended Sediments*). Copco No. 2 Dam remaining in place under the Two Dam Removal Alternative would not alter the amount of sediment-associated oxygen demand compared to under the Proposed Project as the dam does not retain appreciable amounts of sediment under existing conditions (USBR 2011b) and it is not expected to trap appreciable amounts of sediment during drawdown. While there would be some reduction in SSCs downstream of Copco No. 1 due to no sediment being released by J.C. Boyle Dam removal, the overall short-term effects of sediment release and SSCs on sediment-associated oxygen demand and dissolved oxygen concentrations in the Hydroelectric Reach from downstream of Copco No. 1 Dam to Iron Gate Dam under the Two Dam Removal Alternative would still be similar to effects for the Hydroelectric Reach under the Proposed Project and impact significance associated with SSCs and SSC associated oxygen demand and dissolved oxygen concentration would be as described for the Proposed Project (see Potential Impact 3.2-9 for additional details for additional details).

Less sediment would be mobilized into the Middle Klamath River under the Two Dam Removal Alternative; therefore, the extent of downstream increases in oxygen demand (Immediate Oxygen Demand [IOD] and Biological Oxygen Demand [BOD]) and reductions in dissolved oxygen in this reach under the Two Dam Removal Alternative would be somewhat less than the following those of the Proposed Project. Since the range of SSCs under the Proposed Project would be greater than those expected under this alternative (see Section 4.5.2.2 *Suspended Sediments*), the range of dissolved oxygen conditions modeled for the Proposed Project would generally bracket those anticipated under the Two Dam Removal Alternative. Minimum dissolved oxygen values likely would occur slightly upstream compared the Proposed Project, but they would still generally occur near RM 191 to 193.1 (approximately 0 to 2 miles downstream from Iron Gate Dam) since the location of minimum dissolved oxygen concentrations does not change much with variations in SSCs (see Table 3.2-13). Similarly, the farthest distance downstream with dissolved oxygen less than 5 mg/L likely would shift slightly upstream, but the distance would be similar to the Proposed Project (i.e., approximately RM 145 to RM 122 or within 48 to 71 miles downstream of Iron Gate Dam) since it does not change much with variations in SSCs. Minimum dissolved oxygen values would likely show a greater relative increase under the Two Dam Removal Alternative compared the Proposed Project, since the amount of IOD and BOD downstream of Iron Gate Dam is strongly influenced by variations in SSCs and there would be less sediment transported under this alternative.

Despite the potential for a slightly shorter distance of short-term impacts due to decreases in the sediment-associated oxygen demand and a reduction in the magnitude of the decrease in dissolved oxygen in the Middle Klamath River under the Two Dam Removal Alternative, the release of sediments trapped behind Copco No. 1 and Iron Gate Dam would decrease dissolved oxygen concentrations in the Klamath River below the Basin Plan water quality objective for dissolved oxygen (90 percent saturation) in the short term and constitute a significant impact. Additionally, since the location where the minimum and at least 5 mg/L dissolved oxygen concentrations occurred during modeling under the Proposed Project did not change much with variations in SSC, it is conservatively estimated that the distance the significant impact from the short-term increase in sediment-associated oxygen demand and reductions in dissolved oxygen under the Two Dam Removal Alternative occurs would be similar to that modeled under the Proposed Project (Potential Impact 3.2-9), so the short-term impact would remain significant in the Middle Klamath River from Iron Gate Dam to approximately the confluence with the Salmon River (RM 66).

Similarly, it is conservatively estimated that the distance where there would be no significant impact on dissolved oxygen from releases of reservoir deposited sediments under the Two Dam Removal Alternative would be similar to that modeled under the Proposed Project. Modeling under the Proposed Project indicates that downstream of the confluence with the Salmon River on the Middle Klamath River, as well as in the Lower Klamath River and the Klamath River Estuary, there would be no significant impact from the release of sediments trapped behind the Lower Klamath Project dams (see Section 3.2.5.4 *Dissolved Oxygen*). Thus, there also would be no significant impact under the Two Dam Removal Alternative in the Middle Klamath River from downstream of the confluence with the Salmon River, the Lower Klamath River, and the Klamath River Estuary.

In the long term, since J.C. Boyle Dam would remain in place, continuing summertime interception and retention of sediments and suspended materials from upstream sources containing high biological oxygen demand (see also 3.2.2.5 *Dissolved Oxygen*) would still occur in J.C. Boyle Reservoir under the Two Dam Removal Alternative. Accordingly, existing large summertime variations in dissolved oxygen in J.C. Boyle Reservoir, especially at depth, would still occur and could continue to influence dissolved oxygen concentrations in the California portion of the Hydroelectric Reach in the same manner as under existing conditions (see also 3.2.2.5 *Dissolved Oxygen*). Modeling of existing conditions indicates these summertime dissolved oxygen variations in J.C. Boyle Reservoir increase the range of dissolved oxygen concentrations between the Oregon-California state line and the upstream end of Copco No. 1 Reservoir (North Coast Regional Board 2011), but aeration and fast water velocities within the free-flowing reach result in dissolved oxygen concentrations near or slightly greater than saturation upstream of Copco No. 1 Reservoir (FERC 2007; Raymond 2008). The Two Dam Removal Alternative would not include peaking power generation and release of flow for recreation within the J.C. Boyle Peaking Reach, but the dissolved oxygen at the Oregon-California state line would still likely have slightly greater daily variability than natural conditions (see also Potential Impact 3.2-10). While the degree of influence of peaking flows on daily variability in dissolved oxygen concentrations at the Oregon-California state line is not clearly defined by existing information, the daily variability is not currently adversely affecting beneficial uses. However, dissolved oxygen concentrations immediately downstream of J.C. Boyle would potentially fall below 85 percent saturation and 6.5 mg/L during summer similar to existing conditions. Thus, retaining J.C. Boyle Dam with no peaking or recreation flows under the Two Dam Removal Alternative would have only a small influence on dissolved oxygen concentrations downstream of the Oregon-California state line compared to existing conditions and there would be no significant impact.

Within the Hydroelectric Reach downstream of Copco No. 1 Reservoir, the long-term effects of the Two Dam Removal Alternative on dissolved oxygen concentrations would be the same as effects described for the Proposed Project (Potential Impact 3.2-10) as conversion of Copco No. 1 and Iron Gate reservoirs to free-flowing riverine reaches with higher velocities and more turbulent mixing would increase aeration of Klamath River. Additionally, keeping Copco No. 2 Dam and Reservoir in place would not alter dissolved oxygen concentrations in the Klamath River since Copco No. 2 Reservoir has a short residence time (less than a day) and it is not anticipated to retain appreciable amounts of fine sediment or suspended material that would alter dissolved oxygen conditions under the Two Dam Removal Alternative (see Section 4.5.2.2 *Suspended Sediments*). The extreme super-saturated surface water and oxygen-depleted hypolimnion conditions found in existing conditions in April/May to October/November would not occur under the Two Dam Removal Alternative as Copco No. 1 and Iron Gate reservoirs would be removed (see Section 3.2.5.4 *Dissolved Oxygen* for details). While Klamath TMDL modeling scenarios[212] included the removal of Copco No. 2 Dam, modeling results of the conversion of Copco No. 1, Copco No. 2, and Iron Gate reservoirs to free-flowing river reaches scenario are still likely representative of conditions under the Two Dam Removal Alternative because the small size and short residence time of Copco No. 2 Dam would be unlikely to influence dissolved oxygen conditions in the Klamath River. The Klamath TMDL modeling for this scenario indicates seasonal extremes in dissolved oxygen concentrations downstream of Iron Gate Dam would be eliminated (see Section 3.2.5.4 *Dissolved Oxygen* for details). Thus, the long-term effects of dam removal on concentrations of dissolved oxygen in the Middle and Lower Klamath, the Klamath River Estuary, and the Pacific Ocean nearshore environment under the Two Dam Removal Alternative would be the same as those described for the Proposed Project.

[212] While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*).

In summary, relative to existing conditions, the potential impacts of the Two Dam Removal Alternative on increased IOD and BOD and dissolved oxygen would be the same as or similar to those described for the Proposed Project, except as follows:

- There would be no short-term increases in IOD and BOD or reductions in dissolved oxygen in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir since sediment deposits in J.C. Boyle Dam would remain in place (Potential Impact 3.2-9). Copco No. 2 Dam remaining in place would not accumulate appreciable sediments during drawdown, and therefore, would not alter short-term IOD, BOD, and dissolved oxygen compared to the Proposed Project, short-term increases in IOD and BOD along with reductions in dissolved oxygen due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams (Potential Impact 3.2-9) would result in a significant and unavoidable impact in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle Klamath River from Iron Gate Dam to approximately the confluence with the Salmon River under the Two Dam Removal Alternative, similar to the Proposed Project. There would be no significant impact in the Middle Klamath River downstream of the confluence with the Salmon River, Lower Klamath River, and the Klamath River Estuary under the Two Dam Removal Alternative, similar to the Proposed Project. The short-term significant impact of increases in IOD and BOD and reductions in dissolved oxygen due to release of sediments in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, and the Klamath River Estuary cannot be avoided or substantially decreased through reasonably feasible mitigation.
- Potential long-term alterations in daily variability of dissolved oxygen concentrations in the Hydroelectric Reach in California due to the elimination of hydropower peaking flows at J.C. Boyle Dam (Potential Impact 3.2-10) would result in no significant impact. However, long-term increases in dissolved oxygen, as well as increased daily variability in dissolved oxygen, due to conversion of the Copco No. 1 and Iron Gate reservoirs to a free-flowing river (Potential Impact 3.2-10) would be the same under the Two Dam Removal Alternative as under the Proposed Project. Copco No. 2 Dam and Reservoir staying in place under the Two Dam Removal Alternative would not alter dissolved oxygen concentrations compared to the Proposed Project due to its short residence time (less than a day) and minimal long-term sediment retention. Thus, under the Two Dam Removal Alternative there would be no significant impact for daily fluctuations in the Hydroelectric Reach between Copco No. 1 and Iron Gate Dam and the Middle Klamath River immediately downstream of Iron Gate Dam, would be beneficial for elimination of summer and fall extremes in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam, and would result in no significant impact in the Lower Klamath River and Klamath River Estuary.

4.5.2.5 pH

In general, the Two Dam Removal Alternative would have the same or similar potential impacts on pH as those identified under the Proposed Project. As J.C. Boyle Reservoir and peaking power generation and whitewater recreation flows downstream of J.C. Boyle Dam do not substantially alter pH in the downstream river under existing conditions, leaving this dam in place and ceasing peaking and recreation flows would be unlikely to impact pH relative to existing conditions in either the short-term or long-term. Under the existing conditions in Copco No. 1 and Iron Gate reservoirs, seasonal and daily pH is characterized by high pH (greater than 9 s.u.) and large (0.5 to 1.5 s.u.) daily fluctuations occurring in reservoir surface waters during periods of intense phytoplankton blooms (see Section 3.2.2.6 *pH*). Klamath River TMDL modeling[213] for the Proposed Project indicates that removal of these two reservoirs, which would occur under the Two Dam Removal Alternative, would eliminate the occurrences of high pH and large daily fluctuations in pH in these reaches, because the free-flowing reaches of the river replacing these reservoirs would not support the intense phytoplankton blooms that are driving the existing pH conditions (see Section 3.2.5.5 *pH*). Due its small size and low retention time, Copco No. 2 Reservoir does not affect pH under existing conditions and keeping it in place under the Two Dam Removal Alternative also would not affect pH within the Hydroelectric Reach or downstream reaches. In the Klamath River downstream from Iron Gate Dam, pH conditions under the Two Dam Removal Alternative would be the same as under the Proposed Project (Potential Impact 3.2-11).

In summary, relative to existing conditions, the potential impacts of the Two Dam Removal Alternative on pH would be the same as or similar to those as described for the Proposed Project (Potential Impact 3.2-11). Thus, there would be no significant impact in the short term or long-term to pH in the Hydroelectric Reach between J.C. Boyle Dam and the upstream end of Copco No. 1 Reservoir since J.C. Boyle Reservoir does not substantially alter pH in the river downstream from this dam under existing conditions (Potential Impact 3.2-11). While retaining Copco No. 2 Dam would not alter pH conditions in the Klamath River, short-term and long-term decreases in summertime pH and daily pH fluctuations due to a conversion of the Copco No. 1 and Iron Gate reservoir areas to a free-flowing river (Potential Impact 3.2-11) would be beneficial for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, and would have no significant impact for the Middle Klamath River, the Lower Klamath River, and the Klamath River Estuary.

4.5.2.6 Chlorophyll-a and Algal Toxins

In general, the Two Dam Removal Alternative would have the same or similar potential impacts on chlorophyll-*a* and algal toxins as those identified under the Proposed Project (see Section 3.2.5.6 *Chlorophyll-a and Algal Toxins*). The shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days at average flows) of J.C. Boyle Reservoir does not promote the low mixing conditions or thermal stratification that create optimal habitat for phytoplankton growth, so the reservoir does not have large phytoplankton blooms (as measured by chlorophyll-a) under existing conditions (see Figure 3.2-5). Under existing conditions, peaking power generation flows occur in the late afternoons and early evenings to meet high power demand, and J.C. Boyle Reservoir refills during the night when power demand is minimal. Daily fluctuations in the reservoir water level under existing operations increases mixing in the reservoir, making the reservoir slightly less suitable habitat for phytoplankton during the season of maximum phytoplankton and cyanobacteria (blue-green-algae) growth in the system. Ceasing peaking power generation flows would reduce daily reservoir water level fluctuations in J.C. Boyle Reservoir because the facility would no longer be operated to draw on reservoir storage to support daily peaks in hydropower production when there is

[213] While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*).

not sufficient river flow for peak production (3,000 cfs), as occurs during the summer and fall low flow period under existing conditions. However, the residence time of J.C. Boyle Reservoir without peaking operations would still be short (i.e., on the order of one to three days), so leaving this dam in place and ceasing peaking flows would be unlikely to create conditions that would support large seasonal phytoplankton blooms or increase chlorophyll-*a* concentrations relative to existing conditions. Concentrations of the algal toxin microcystin are generally low in J.C. Boyle Reservoir (Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*) and in the Hydroelectric Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir since the J.C. Boyle Reservoir does not support large blooms of toxigenic blue-green algae and springs downstream of J.C. Boyle Dam dilute any algal toxins that may be present within that reach. Thus, leaving J.C. Boyle Dam in place and ceasing peaking flows would not promote conditions that would support production of algal toxins.

In Copco No. 1 and Iron Gate reservoirs, existing conditions for chlorophyll-*a* levels in summer and early fall can be two to 10 times greater than those recorded in the mainstem river upstream of Copco No. 1 Reservoir near Shovel Creek. High chlorophyll-*a* readings in the reservoirs as compared to the Klamath River are in part due to the lower mixing conditions and longer residence times of these reservoirs (10.7 days for Copco No. 1 and 14.8 days for Iron Gate at average flows) that promote the growth of phytoplankton and the associated production of chlorophyll-*a* within the reservoirs. Additionally, measurements of microcystin in Copco No. 1 and Iron Gate reservoirs during summer months show high microcystin concentrations, especially during algal blooms when microcystin concentrations measured between 2006 and 2015 exceeded the State Water Board et al. (2010, updated 2016) threshold of 0.8 ug/L and peaked from 64 ug/L in Iron Gate Reservoir to 73,000 ug/L in Copco No. 1 Reservoir (Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*). Under the Two Dam Removal Alternative, elimination of Copco No.1 and Iron Gate reservoirs, which currently support growth conditions for toxin-producing nuisance algal species such as *Microcystis aeruginosa,* would result in decreases in high seasonal concentrations of chlorophyll-*a* and periodically high levels of algal toxins generated by suspended blue-green algae, consistent with the Proposed Project (see Section 3.2.5.6 *Chlorophyll-a and Algal Toxins*). The removal of Copco No. 1 and Iron Gate reservoirs also would eliminate the primary habitat for blue-green algae in the Hydroelectric Reach, reducing both the amount of blue-green algae present that could contribute to chlorophyll-*a* and algal toxins within this reach and the amount of blue-green algae that may be exported into the Klamath River downstream of Iron Gate Dam. Due its small size and low residence time (less than a day), Copco No. 2 Reservoir does not have the habitat conditions (i.e., slow water velocity, low mixing conditions, or thermal stratification) that would promote phytoplankton growth and alter chlorophyll-*a* and algal toxins concentrations under existing conditions and keeping it in place under the Two Dam Removal Alternative also would not affect chlorophyll-*a* and algal toxins within the Hydroelectric Reach or downstream reaches.

As phytoplankton and the resulting chlorophyll-*a* and algal toxin levels (e.g., microcystin) are primarily internally generated in Copco No. 1 and Iron Gate reservoirs, removal of these reservoirs under the Two Dam Removal Alternative would also reduce the transport of chlorophyll-a and algal toxins to the Klamath River downstream of Iron Gate Dam in both the short-term and the long-term, consistent with the Proposed Project.

In summary, relative to existing conditions, the potential impacts and impacts of the Two Dam Removal Alternative on chlorophyll-*a* and algal toxins would be the same as or similar to those described for the Proposed Project, except as follows:

- There would be no short-term or long-term alterations in chlorophyll-a and algal toxins in the Hydroelectric Reach between J.C. Boyle Dam and the upstream end of Copco No. 1 Reservoir since J.C. Boyle Reservoir would remain in place, but it does not support conditions promoting large phytoplankton blooms and associated chlorophyll-a and algal toxins under existing conditions (Potential Impact 3.2-12). However, short-term and long-term reduction of chlorophyll-a and algal toxin levels due to a conversion of the reservoir areas to a free-flowing river (Potential Impact 3.2-12) under the Two Dam Removal Alternative would be beneficial for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, the Middle Klamath River, Lower Klamath River, and Klamath River Estuary, similar to the Proposed Project.

4.5.2.7 Inorganic and Organic Contaminants

Short-term mobilization of J.C. Boyle reservoir sediment deposits would not occur under the Two Dam Removal Alternative and none of the associated 1,190,000 cubic yards of deposits (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches. While Copco No. 2 Dam would remain in place, it does not retain appreciable amounts of sediment (USBR 2011b) and it is unlikely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*), thus the short-term mobilization of reservoir sediment deposits and potential sediment-associated inorganic and organic contaminants in the Copco No. 2 section of the Hydroelectric Reach under the Two Dam Removal Alternative would be similar to under the Proposed Project. Mobilization of reservoir sediment deposits in the much larger Copco No. 1 and Iron Gate reservoirs would still occur such that the short-term potential for mobilization of inorganic and organic contaminants in the Hydroelectric Reach from downstream of Copco No. 1 Dam to Iron Gate Dam under the Two Dam Removal Alternative would be similar to impacts for the Hydroelectric Reach under the Proposed Project (Section 3.2.5.7 *Inorganic and Organic Contaminants*).

Mobilization of sediments from J.C. Boyle Reservoir are anticipated to not significantly impact freshwater benthic organism survival under the Proposed Project after consideration of dispersal and dilution, but testing of sediments from J.C. Boyle Reservoir without any dispersal or dilution suggests a higher potential for toxicity to freshwater benthic organisms compared to Copco No. 1 and Iron Gate reservoir sediments (Section 3.2.5.7 *Inorganic and Organic Contaminants*). Thus, the potential for toxicity to freshwater benthic organisms may be relatively slightly less under the Two Dam Removal Alternative than that of the Proposed Project due to no sediment from J.C. Boyle Reservoir being transported downstream. However, the overall impact of the release of sediments trapped behind Lower Klamath Project dams under both the Two Dam Removal Alternative and under the Proposed Project would be expected to be similar. The Proposed Project analysis assumes mixing of sediment deposits from all the reservoirs as they move downstream and exposure of downstream aquatic biota to an “average” sediment composition, rather than a reservoir-specific composition (Section 3.2.5.7 *Inorganic and Organic Contaminants*), so overall water column toxicity due to the concentration of inorganic or organic substances under the Proposed Project is unlikely. As such, there would be a less than significant impact due to the release of sediments trapped behind Lower Klamath Project dams, including J.C. Boyle Dam, under the Proposed Project. While leaving J.C. Boyle Dam in place and not releasing J.C. Boyle reservoir deposited sediments under the Two Dam Removal Alternative would potentially slightly reduce toxicity to benthic freshwater organisms, the overall impact from the release of Copco No. 1 and Iron Gate reservoir deposited sediments and the sediment-associated inorganic and organic contaminants would be a less than significant impact in the short term under the Two Dam Removal Alternative, similar to the Proposed Project.

While the overall extent of fish passage construction activities at J.C. Boyle and Copco No. 2 dams and dam deconstruction activities at Copco No. 1 and Iron Gate dams in the Hydroelectric Reach under the Two Dam Removal Alternative would be slightly less than the extent of dam deconstruction activities for all four dams in the Hydroelectric Reach under the Proposed Project (see also 4.5.1 *[Two Dam Removal Alternative] Introduction – Alternative Analysis Approach*), short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration activities under the Two Dam Removal Alternative would be similar to those described for the Proposed Project and they would be potentially significant impacts without mitigation in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam. Implementation of mitigation measures WQ-1, TER-1, and HZ-1 would reduce impacts to less than significant.

In the long term, existing inorganic and organic contaminant data characterizing J.C. Boyle Reservoir sediment deposits indicate that a relatively small number of chemicals (i.e., mercury, DDTs, and possibly dioxin-like chemicals) are present at levels that have the potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) to freshwater aquatic species remaining in this reservoir under the Two Dam Removal Alternative. Elutriate sediment sample bioassay results from J.C. Boyle Reservoir indicate that no further dilution would be required to prevent water column toxicity to freshwater fish. Relative to existing condition, there would be no change. Copco No. 2 Reservoir remaining in place would also be similar to existing conditions since it neither contains appreciable sediment deposits nor is it expected to accumulate appreciable amounts of sediment with associated inorganic or organic contaminants (i.e., fine sediments) in the long term (see Section 4.5.2.2 *Suspended Sediment*). However, long-term retention of inorganic and organic contaminants contained within existing sediment deposits behind Copco No. 1 and Iron Gate dams and their potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) would not occur since they would be removed under the Two Dam Removal Alternative, which would be beneficial.

In summary, relative to existing conditions the potential impacts and impacts of the Two Dam Removal Alternative on inorganic and organic contaminants would be the same as or similar to those described for the Proposed Project, except as noted below:

- J.C. Boyle Reservoir sediment deposits and its sediment-associated inorganic and organic contaminants would not be released downstream, but the short-term and long-term human exposure to inorganic and organic contaminants due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams (Potential Impact 3.2-13) would result in a potentially significant impact for the Hydroelectric Reach, Middle Klamath River, Lower Klamath River, and Klamath River Estuary.

Implementation of, mitigation measures WQ-2 and WQ-3 would result in no significant impact.

- While J.C. Boyle Reservoir sediment deposits and its sediment-associated inorganic and organic contaminants would not be released downstream and Copco No. 2 would remain in place, the short-term and long-term freshwater aquatic species' exposure to inorganic and organic contaminants due to release of sediments currently trapped behind the Copco No. 1 and Iron Gate dams (Potential Impact 3.2-14) would result in no significant impact for the Hydroelectric Reach, Middle Klamath River, Lower Klamath River, Klamath River Estuary, and Pacific Ocean nearshore environment based on sediment screening and/or laboratory toxicity results after consideration of dilution conditions during drawdown.
- Short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration activities (Potential Impact 3.2-15) in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam would be potentially significant without mitigation. Implementation of Mitigation Measure WQ-1 would result in no significant impact.
- Short-term impacts to aquatic biota from herbicide application during restoration of the reservoir footprint area (Potential Impact 3.2-16) would be potentially significant without mitigation. Implementation of Mitigation Measure WQ-4 would result in no significant impact.
- Long-term freshwater aquatic species' exposure to inorganic and organic contaminants contained within J.C. Boyle Reservoir sediment deposits would continue to have the potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) to some freshwater aquatic species in the reservoir (Potential Impact 4.2.2-8), which would be no impact (no change from existing adverse conditions).

4.5.2.8 General Water Quality

Iron Gate Hatchery operations would continue, and Fall Creek Hatchery would reopen, for eight years under the Two Dam Removal Alternative. The potential short-term and long-term impacts of these operations on the Klamath River, Bogus Creek, and Fall Creek water quality would be the same as described for the Proposed Project (Potential Impact 3.2-17).

4.5.3 Aquatic Resources

4.5.3.1 Suspended Sediment

As discussed in Section 4.5.2.2 *Suspended Sediments*, while there would be some reduction in SSCs downstream of Copco No. 1 due to no SSCs being released by Copco No. 2 and J.C. Boyle Dam removal, the reduction of SSCs under the Two Dam Removal Alternative would not alter the overall impact of dam removal on SSCs compared to the Proposed Project in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, or the nearshore marine environment. Thus, the potential impacts of suspended sediment on aquatic resources in California would be the same under the Two Dam Removal Alternative as those described under the Proposed Project (see also Section 3.3.5.1 *Suspended Sediment*).

4.5.3.2 Bed Elevation and Grain Size Distribution

Because the volume of stored sediment in Copco No. 2 and J.C. Boyle reservoirs is relatively small compared with the volume of stored sediment in Copco No. 1 and Iron Gate reservoirs, the potential for alterations in bed elevation and grain size distribution and the associated effects on aquatic resources in California would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (see also Section 3.3.5.2 *Bed Elevation and Grain Size Distribution*). Thus, downstream impacts to aquatic species due to bed elevation and grain size distribution would be very similar to those described for the Proposed Project.

4.5.3.3 Water Quality

For the reasons discussed below, potential impacts of water quality on aquatic resources in California would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (see also Section 3.3.5.3 *Water Quality*). As Copco No. 1 and Iron Gate reservoirs are the largest of the four Lower Klamath Project reservoirs, they have the greatest impact on water quality (FERC 2007), and their removal would result in water quality conditions similar to those of the Proposed Project. Because of their relatively small size and short residence time, continuing to store water within Copco No. 2 and J.C. Boyle reservoirs would generally not result in the same poor water temperature conditions that occur downstream of the larger Lower Klamath Project reservoirs (Iron Gate and Copco No. 1 reservoirs) under existing conditions. Section 4.5.2 discusses the impacts of the Two Dam Removal Alternative with an emphasis on similarities and differences with the potential impacts of the Proposed Project.

The Two Dam Removal Alternative includes no peaking power generation or release of flow for recreation at J.C. Boyle Dam. As described in Section 3.2.2.2 *Water Temperature*, daily peaking operations at J.C. Boyle Powerhouse (RM 225.2) result in an increase in the daily water temperature range in the Bypass Reach because warmer reservoir discharges are diverted around this reach and cold groundwater springs enter the river and dominate remaining flows. The temperature effects of altering the flow regime under the Two Dam Removal Alternative (while keeping J.C. Boyle Dam in place) would be a reduction in diel (24-hour) temperature variation and overall warmer water temperatures in the Bypass Reach during summer and early fall compared with existing conditions. In the Peaking Reach, water temperature effects would be the same as under the Proposed Project (i.e., slightly lower maximum water temperatures and less artificial diel [24-hour] temperature variation during summer and early fall) since no peaking flows would occur and the effect of J.C. Boyle thermal mass on water temperatures does not extend this far downstream (see also Section 4.5.2.1 *Water Temperature*).

In the Hydroelectric Reach from the upstream end of Copco No. 1 Reservoir to Iron Gate Dam, removing Iron Gate, Copco No. 1, and Copco No. 2 reservoirs and converting the reservoir areas to a free-flowing river under this alternative would result in the same effects on water temperatures in the Middle Klamath River immediately downstream from Iron Gate Dam as described for the Proposed Project (i.e., long-term increases in spring water temperatures and decreases in late summer/fall water temperatures) (see Section 3.3.5.3 *Water Quality*).

4.5.3.4 Fish Disease and Parasites

For the reasons discussed below, potential impacts of fish disease and parasites on aquatic resources in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.5 *Fish Disease and Parasites*). The main factors contributing to risk of juvenile salmonid infection by *C. shasta* and *P. minibicornis* include availability of habitat (pools, eddies, and sediment) for the polychaete intermediate host; microhabitat characteristics (static flows and low velocities); congregations of spawned adult salmon with high spore; polychaete proximity to spawning areas; planktonic food sources from Lower Klamath Project reservoirs; and water temperatures greater than 59°F (Bartholomew and Foott 2010). The current reach with highest infectivity (nidus) for *C. shasta* and *P. minibicornis* is located in the Klamath River downstream of Iron Gate Dam, where returning adult spawners congregate. For adult salmon, *Ichthyophthirius multifis* (Ich) and *Flavobacterium columnare* (columnaris) have occasionally resulted in substantial mortality, particularly when habitat conditions include exceptionally low flows, high water temperatures, and high densities of fish (such as adult Chinook salmon migrating upstream in the fall and holding at high densities in pools). This section addresses differences between these disease factors anticipated under the Two Dam Removal Alternative in comparison with the Proposed Project, and implications for effects on juvenile and adult salmonid life stages.

The availability of habitat for the polychaete worm intermediate host is driven by sediment transport and hydrologic dynamics that as described in sections above would be nearly the same as the Proposed Project. The relatively low volume of sediment in Copco No. 2 and J.C. Boyle reservoirs would not appreciably affect habitat for the polychaete host relative to existing conditions, and the hydrology affecting microhabitat characteristics would be the same as that described for the Proposed Project. The reduction in congregations of spawned adults with proximity to polychaetes would be similar to the Proposed Project, since anadromous salmonids would have upstream migratory access past Iron Gate Dam, including provision of fish passage at Copco No. 2 and J.B. Boyle Dam, and would be as widely distributed. As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing and emergency dilution flows are required to be released from Iron Gate Dam as part of re-initiation of consultation on the 2013 BiOp Flows, but they are not modeled as part of existing conditions hydrology. Under the Two Dam Removal Alternative, it is anticipated that the nidus would no longer form downstream of Iron Gate Dam, and the risk of a new nidus forming upstream is low, even in the absence of the 2017 flow requirements (see also Section 3.3.5.5 *Fish Disease and Parasites*). Although the conditions leading to a reach that would exhibit the highest infectivity (nidus) for *C. shasta* and *P. minibicornis* downstream of Iron Gate Dam would be ameliorated once Copco No. 1 and Iron Gate dams are removed, some disease factors would continue under the Two Dam Removal Alternative, including eight years of additional Iron Gate Hatchery operations potentially resulting in continued (through post-dam removal year 10) congregations of mostly adult fall-run Chinook salmon in the reach from Iron Gate Dam to Seiad Valley (see also Section 3.3.5.6 *Fish Hatcheries*). Under the Two Dam Removal Alternative, if a nidus were to remain in the vicinity of Iron Gate Hatchery, or theoretically were to form within newly accessible upstream habitat such as the reach immediately downstream of Copco No. 2 or J.C. Boyle dam where future fish passage facility entrances would be located, flushing and emergency dilution flows as required by the 2017 court order may be required from a new upstream location to achieve the same ecological benefits (i.e., disruption of nidus).

Under the Two Dam Removal Alternative, planktonic (e.g., floating organisms such as algae) food sources would be reduced relative to existing conditions with elimination of reservoir habitats, similar to conditions under the Proposed Project. However, because Copco No. 2 and J.C. Boyle reservoirs would remain it would continue to provide a source of planktonic food for the polychaete host of *C. shasta* and *P. minibicornis*. Therefore, while planktonic food sources would be reduced under the Two Dam Removal Alternative relative to existing conditions, slightly more reservoir (and thus planktonic food source) would be removed under the Proposed Project.

Conditions resulting in water temperatures greater than 59°F downstream of Iron Gate Dam under the Two Dam Removal Alternative would be the same as those identified under the Proposed Project. As described in Section 4.5.2.1 *Water Temperature*, the presence of the Copco No. 2 and J.C. Boyle reservoirs on the Klamath River do not alter water temperatures in further downstream reaches J.C. Boyle Reservoir has a shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days) that does not support thermal stratification (FERC 2007), and Copco No. 2 Reservoir has a small volume (approximately 70 acre-feet originally), a short hydraulic residence time (less than a day), no active storage, and it does not thermally stratify, such that the reservoir has a negligible impact on water temperature.

Under the Two Dam Removal Alternative, the conditions that can support Ich and columnaris outbreaks among adult salmonids (i.e., exceptionally low flows, high water temperatures, and high densities of fish), would be similar to those identified under the Proposed Project, especially within the Lower Klamath River where Ich and columnaris have caused substantial mortality under existing conditions. Downstream of the confluence with the Salmon River neither the Proposed Project or the Two Dam Removal Alternative would have a pronounced effect on instream flows, water temperatures, or congregations of fish, due to the contributions of several large tributaries (notably the Trinity River). Overall, impacts to aquatic species due to fish disease and parasites would improve relative to existing conditions under the Two Dam Removal Alternative and they would be very similar to those described for the Proposed Project.

4.5.3.5 Fish Hatcheries

The potential impacts of fish hatcheries on aquatic resources in the California portions of the Klamath River would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.6 *Fish Hatcheries*). As this alternative includes volitional fish passage at Copco No. 2 and J.C. Boyle dams consistent with mandatory conditions issued for relicensing of the Klamath Hydroelectric Project, thereby eliminating Copco No. 2 and J.C. Boyle dams as fish barriers, this alternative assumes that hatchery operations would continue for eight years under the Two Dam Removal Alternative and then the hatcheries would be removed. During the eight years following removal of Copco No. 1 and Iron Gate dams, the hatcheries would operate with reduced production goals consistent with those described for the Proposed Project (see Section 2.7.6 *Hatchery Operations*).

4.5.3.6 Algal Toxins

Potential impacts of algal toxins on aquatic resources in the California portions of the Klamath River would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.7 *Algal Toxins*). Removal of the larger Copco No. 1 and Iron Gate reservoirs would decrease or eliminate support for excessive growth of phytoplankton, including seasonal blue-green algae blooms and associated algal toxins (e.g., microcystin), by eliminating large areas of quiescent habitat where these phytoplankton species currently thrive. While Copco No. 2 and J.C. Boyle reservoirs would remain, because of their small sizes (Table 2.3-1) and short hydraulic residence times (Table 3.6-4), they would not support substantial blooms and thus the expected decrease in algal toxins anticipated under the Two Dam Removal Alternative would be the same as described for the Proposed Project. Additionally, potential for bioaccumulation of algal toxins in freshwater mollusk and fish tissue under the Two Dam Removal Alternative would be expected to decrease in the mainstem Klamath River from the Hydroelectric Reach to the Klamath River Estuary, as described for the Proposed Project.

4.5.3.7 Aquatic Habitat

For the reasons discussed below, potential impacts of aquatic habitat on aquatic resources in California portions of the Klamath River would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.8 *Aquatic Habitat*). Improvements in aquatic habitat conditions resulting from increased minimum flows and eliminated peaking operations in the Bypass Reach downstream of J.C. Boyle Dam based on federal mandatory conditions in the PacifiCorp hydroelectric relicensing process would occur under the Two Dam Removal Alternative as described for the Proposed Project. As described in sections above, changes in sediment dynamics would also be similar to those described under the Proposed Project. Access to additional aquatic habitat upstream of Iron Gate Dam would be the same under the Two Dam Removal Alternative as described for the Proposed Project, since fish passage would be provided at Copco No. 2 and J.C. Boyle dams (see also Section 4.5.3.8 *Fish Passage*). The primary difference under the Two Dam Removal Alternative is that aquatic habitat within Copco No. 2 and J.C. Boyle reservoirs would remain lentic rather than reverting to the riverine conditions described for the Proposed Project. Based on the estimate by Cunanan (2009) of 3.5 miles of riverine habitat currently inundated by J.C. Boyle Reservoir, and an estimated 0.3 miles inundated by Copco No. 2, there would be approximately 3.8 fewer miles of additional riverine habitat that would become available under this alternative compared to the Proposed Project. However, Copco No. 2 and J.C. Boyle reservoir inundation is a small proportion (approximately 16 percent) of the 22 miles of Lower Klamath Project reservoir habitat that would be restored to riverine habitat under the Proposed Project (the original estimate of 22 miles did not take into account the relatively minor inundation at Copco No. 2 Reservoir). In addition, J.C. Boyle Dam would continue to provide reservoir habitat to support aquatic resources (including shortnose and Lost River suckers). Under the Two Dam Removal Alternative, the two larger lower reservoirs would be removed as described for the Proposed Project, restoring approximately 18.5 miles of mainstem river that previously exhibited high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009).

4.5.3.8 Fish Passage

Copco No. 2 Dam is not currently equipped with fish passage facilities (DOI 2007). The current upstream fishway at J.C. Boyle Dam is obsolete and does not meet NMFS (2011) design criteria (U.S. Department of Interior, DOI 2007). Under the Two Dam Removal Alternative, fish would have access beyond the location of Copco No. 1 and Iron Gate dams, as described for the Proposed Project (Section 3.3.5.8 *Aquatic Habitat*). However, whereas under the Proposed Project fish would have volitional unimpeded access past Copco No. 2 and J.C. Boyle dams, under the Two Dam Removal Alternative fish migrating upstream and downstream past Copco No. 2 and J.C. Boyle dams would access upstream habitat via fishways. DOI (2007) included a prescription for a NMFS-criteria volitional year-round fish ladder at Copco No. 2 and J.C. Boyle dams to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. In addition, DOI (2007) prescribed a new year-round NMFS criteria fish screen and a bypass facility at Copco No. 2 and J.C. Boyle dams (and modifications to spillways) to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, redband trout, and listed sucker species. Under the Two Dam Removal Alternative, fishways would be consistent with the prescriptions from the DOI and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007), and specific fishway facility design and construction details included in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*[215], including fishway (i.e., fish ladder and screens) installation for both upstream and downstream migrations and barriers to prevent juvenile salmonid entrainment into turbines. Use of trap and haul would involve design assumptions described in the Section 4.4 *Continued Operations with Fish Passage Alternative,* but the assumptions would only be applied to Copco No. 2 and J.C. Boyle dams. In this EIR, it is assumed that for application at these two dams (Copco No. 2 and J.C. Boyle dams), if alternative passage facilities were designed and constructed, they would necessarily meet agency criteria and thus would have an equivalent level of mortality as volitional fishways.

In their preliminary fishway prescriptions for the Lower Klamath Project dams, NMFS (2006) recommended dam removal to FERC under FPA S10(a) and (j) as the environmentally preferred alternative to provide the least mortality and injury to migrating fish. The associated NMFS fishway prescription (DOI 2007) is a mandatory conditioning authority that was submitted during the hydropower relicensing process at the time, in case FERC chose to reject NMFS' strong recommendation to removal all of the Lower Klamath Project mainstem dams. While unimpeded volitional fish passage is assumed to have higher survival and lower injury than fishways, no data or analyses are available to accurately compare the effectiveness of unimpeded fish passage under the Proposed Project with volitional fishways under the Two Dam Removal Alternative. NMFS does not provide an expected level of mortality or injury in association with fishways constructed to their criteria, and performance would depend on many site-specific factors that would be considered in the design phase of new fishways. Based on the measured effectiveness of fishways constructed to NMFS criteria at other dams (DWR 2013), this EIR assumes at least 98 percent survival (or less than 2 percent mortality) of upstream and downstream migrating aquatic species at each facility in recognition that while survival could be high at properly constructed facilities, it is unlikely to be as high as survival would be with dams removed (i.e., 100 percent). Therefore, the assumed cumulative upstream mortality for fish migrating past both Copco No. 2 Dam and J.C. Boyle Dam would be around 4 percent, and the same for downstream mortality.

Regardless of how fish passage is provided, this alternative assumes fish passage consistent with the general prescriptions (DOI 2007) that cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007). This EIR also assumes that effects of passage through volitional fishways would be equivalent for other migratory species, which appears to be a reasonable assumption based on available data (DWR 2013) for fishways designed and constructed to modern agency criteria as required by DOI (2007).

Based on the similarities between the Two Dam Removal Alternative and the Proposed Project for several of the key ecological attributes discussed above, the potential impacts of the Two Dam Removal Alternative would be the same as those described under the Proposed Project for several potential impacts (Potential Impact 3.3-2, 3.3-3, 3.3-5, 3.3-6, 3.3-12, 3.3-15, 3.3-16, 3.3-18, 3.3-20, 3.3-21, 3.3-22, 3.3-23, and 3.3-24). The potential impacts of the Two Dam Removal Alternative that could result in different effects than those already discussed under the Proposed Project are discussed below.

Potential Impact 3.3-1 Effects on coho salmon critical habitat quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on coho salmon critical habitat in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-1), with a few subtle differences. For reasons described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins* impacts on critical habitat from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under Copco No. 2 Reservoir (0.3 miles) and J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. As described in Section 4.5.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at Copco No. 2 and J.C. Boyle dams is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles at each facility, or 4 percent cumulative mortality for migrants that use both facilities. Habitat in the J.C. Boyle Bypass and Peaking Reaches would be improved through elimination of peaking operations and higher baseflows. Therefore, although upstream of current designated critical habitat, the Two Dam Removal Alternative would expand the geographic extent of habitat available to coho salmon in a similar manner to the Proposed Project.

The short-term impacts on coho salmon critical habitat from sediment releases would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-1), for the reasons described in Section 4.5.3.1 *Suspended Sediment* and Section 4.5.3.2 *Bed Elevation and Grain Size Distribution*. Based on the substantial short-term decrease in quality of the features of critical habitat and PCEs supporting SONCC coho salmon, there would be a significant impact to coho salmon critical habitat under the Two Dam Removal Alternative in the short term.

However, as described for the Proposed Project, the Two Dam Removal Alternative includes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) to reduce the short-term effects of SSCs on coho salmon PCEs of critical habitat. In addition, mitigation measures AQR-1 and AQR-2 (described in Section 3.3.5.9), would be implemented to increase certainty of the effectiveness of the aquatic resource measures AR-1 and AR-2 and reduce the short-term significant adverse impacts of the Two Dam Removal Alternative on coho salmon critical habitat. Consistent with the Proposed Project, based on the wide distribution of coho salmon critical habitat within tributaries, aquatic resource measures, and mitigation measures designed to offset short-term impacts to PCEs of critical habitat, there would not be a substantial decrease in the quality of a substantial proportion of habitat for coho salmon critical habitat in the short term. Therefore, the Two Dam Removal Alternative would have no significant impact on coho salmon critical habitat in the short term.

For the reasons described in Section 4.5.3.7 *Aquatic Habitat*, in the long term the Two Dam Removal Alternative would increase the amount of habitat available to coho salmon upstream of currently designated critical habitat and improve water quality and bedload characteristics in the mainstem Klamath River within current critical habitat in the same manner as the Proposed Project. Overall, these changes would be a substantial increase in the quality and quantity of coho salmon critical habitat in the long term as compared to existing conditions. Therefore, the Two Dam Removal Alternative would be beneficial for coho salmon critical habitat in the long term.

Significance

No significant impact with mitigation to coho salmon critical habitat in the short term

Beneficial for coho salmon critical habitat in the long term

Potential Impact 3.3-4 Effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on Chinook and coho salmon EFH in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-4), with a few subtle differences. For reasons described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, impacts on EFH from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under Copco No. 2 Reservoir (0.3 miles) and J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. As described in Section 4.5.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at Copco No. 2 and J.C. Boyle dams is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles at each facility, or 4 percent cumulative mortality for migrants that use both facilities.

The short-term impacts on Chinook and coho salmon EFH from sediment releases would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-4), for the reasons described in Section 4.5.3.1 *Suspended Sediment* and Section 4.5.3.2 *Bed*

Elevation and Grain Size Distribution. Based on the substantial short-term decrease in quality of EFH for Chinook and coho salmon, there would be a significant impact to Chinook and coho salmon EFH under the Two Dam Removal Alternative in the short term.

However, as described for the Proposed Project, the Two Dam Removal Alternative includes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) to reduce the short-term effects of SSCs on Chinook and coho salmon EFH. In addition, mitigation measures AQR-1 and AQR-2 (described in Section 3.3.5.9), would be implemented to increase certainty of the effectiveness of the aquatic resource measures AR-1 and AR-2 and reduce the short-term significant adverse impacts of the Two Dam Removal Alternative on Chinook and coho salmon EFH. Consistent with the Proposed Project, based on the wide distribution and use of tributaries by both juvenile and adult Chinook and coho salmon, aquatic resource measures (AR-1 and AR-2), and mitigation measures (AQR-1 and AQR-2), designed to offset short-term impacts to Chinook and coho salmon EFH, there would not be a substantial decrease in the quality of a large proportion of Chinook and coho salmon EFH in the short term. Therefore, the Two Dam Removal Alternative would have no significant impact, with mitigation, on Chinook and coho salmon EFH in the short term.

For the reasons described above in Section 4.5.3.7 *Aquatic Habitat*, in the long term the Two Dam Removal Alternative would increase habitat for Chinook and coho salmon (upstream of currently designated EFH) by providing access to habitats upstream of Iron Gate Dam in the same manner as the Proposed Project. Overall, these changes would be a substantial increase in the quality and quantity of Chinook and coho salmon EFH in the long term. Therefore, the Two Dam Removal Alternative would be beneficial for Chinook and coho salmon EFH in the long term.

Significance

No significant impact with mitigation to Chinook and coho salmon EFH in the short term

Beneficial for Chinook and coho salmon EFH in the long term

Potential Impact 3.3-7 Effects on the fall-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on fall-run Chinook salmon in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-7), with a few subtle differences. As described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, impacts on fall-run Chinook salmon from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under Copco No. 2 Reservoir (0.3 miles) and J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Based on the 440 miles of fall-run Chinook salmon habitat estimated upstream of Iron Gate Dam (Section 3.3.5.8 *Aquatic Habitat*), the 3.8 miles that would remain inundated by Copco No. 2 and J.C. Boyle reservoirs rather than reverting to riverine habitat under the Two Dam Removal Alternative is not substantial (< 1 percent of newly accessible habitat). Juvenile Chinook salmon would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.5.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at Copco No. 2 and J.C. Boyle dams is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles at each facility, or 4 percent cumulative mortality for migrants that use both facilities. Therefore, the estimated increases in fall-run Chinook salmon abundance predicted to occur under the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-7), would be less under the Two Dam Removal Alternative due to mortality in fish passage facilities and migration through reservoir habitat.

The short-term impacts on fall-run Chinook salmon from sediment releases would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-7), for the reasons described in Section 4.5.3.1 *Suspended Sediment* and Section 4.5.3.2 *Bed Elevation and Grain Size Distribution*. As described for the Proposed Project (Potential Impact 3.3-7), because there would be no substantial short-term decrease in fall-run Chinook salmon abundance of a year class, and no substantial decrease in habitat quality or quantity, there would not be a significant impact to fall-run Chinook salmon under the Two Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on fall-run Chinook salmon In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the Two Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including fall-run Chinook salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Two Dam Removal Alternative on fall-run Chinook salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, in the long term the Two Dam Removal Alternative would increase habitat availability, restore a more natural flow regime and seasonal water temperature variation, improve water quality, and reduce the likelihood of fish disease and algal toxins, all of which would be beneficial for fall-run Chinook salmon in the same manner as the Proposed Project. Overall, the multiple benefits of the Two Dam Removal Alternative would be beneficial for fall-run Chinook salmon in the long term.

Significance

No significant impact for fall-run Chinook salmon populations in the short term

Beneficial for fall-run Chinook salmon populations in the long term

Potential Impact 3.3-8 Effects on the spring-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on spring-run Chinook salmon in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-8), with a few subtle differences. As described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, impacts on spring-run Chinook salmon from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under Copco No. 2 Reservoir (0.3 miles) and J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Based on the 440 miles of spring-run Chinook salmon habitat estimated upstream of Iron Gate Dam (Section 3.3.5.8 *Aquatic Habitat*), the 3.8 miles that would remain inundated by Copco No. 2 and J.C. Boyle reservoirs rather than revert to riverine habitat under the Two Dam Removal Alternative is unsubstantial (< 1 percent of newly accessible habitat). Juvenile Chinook salmon would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.5.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at Copco No. 2 and J.C. Boyle dams is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles at each facility, or 4 percent cumulative mortality for migrants that use both facilities.

The short-term impacts on spring-run Chinook salmon from sediment releases would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-8), for the reasons described in Section 4.5.3.1 *Suspended Sediment* and Section 4.5.3.2 *Bed Elevation and Grain Size Distribution*. As described for the Proposed Project (Potential Impact 3.3-8), because there would not be a substantial short-term decrease in spring-run Chinook salmon abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to spring-run Chinook salmon under the Two Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on fall-run Chinook salmon In the short term, aquatic resource measure AR-2 (Juvenile Outmigration) would occur under the Two Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including spring-run Chinook salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measure AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Two Dam Removal Alternative on spring-run Chinook salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3 *Algal Toxins*, in the long term the Two Dam Removal Alternative would increase habitat availability, restore a more natural flow regime and seasonal water temperature variation, improve water quality, and reduce the likelihood of fish disease and algal toxins, all of which would be beneficial for spring-run Chinook salmon in the same manner as the Proposed Project. Overall, the multiple benefits of the Two Dam Removal Alternative would be beneficial for spring-run Chinook salmon in the long term.

Significance

No significant impact for spring-run Chinook salmon populations in the short term

Beneficial for spring-run Chinook salmon populations in the long term

Potential Impact 3.3-9 Effects on coho salmon populations due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on coho salmon in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-9), with a few subtle differences. As described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, impacts on coho salmon from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion (approximately 80 miles) expected under the Proposed Project (as described in Section 3.3.5.8 *Aquatic Habitat*) would occur, with the exception of habitat under Copco No. 2 Reservoir (0.3 miles) and J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Juvenile coho salmon would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.5.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at Copco No. 2 and J.C. Boyle dams is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles at each facility, or 4 percent cumulative mortality for migrants that use both facilities.

The short-term impacts on coho salmon from sediment releases would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-9), for the reasons described in Section 4.5.3.1 *Suspended Sediment* and Section 4.5.3.2 *Bed Elevation and Grain Size Distribution*. Because there would not be a substantial short-term decrease in coho salmon abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to coho salmon under the Two Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on coho salmon In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the Two

Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including coho salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Two Dam Removal Alternative on coho salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, in the long term the Two Dam Removal Alternative would increase the amount of habitat available to coho salmon and improve water quality and bedload characteristics in the mainstem Klamath River in the same manner as the Proposed Project. Overall, these changes could result in a substantial increase the abundance of coho salmon populations in the long term. Therefore, the Two Dam Removal Alternative would be beneficial for coho salmon in the long term.

Significance

No significant impact for coho salmon populations in the short term

Beneficial for coho salmon populations in the long term

Potential Impact 3.3-10 Effects on the steelhead population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on steelhead in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-10), with a few subtle differences. As described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, impacts on steelhead from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion (approximately 440 miles) expected under the Proposed Project (as described in Section 3.3.5.8 *Aquatic Habitat*) would occur, with the exception of habitat under Copco No. 2 Reservoir (0.3 miles) and J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Juvenile steelhead would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.5.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at Copco No. 2 and J.C. Boyle dams is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles at each facility, or 4 percent cumulative mortality for migrants that use both facilities.

The short-term impacts on steelhead from sediment releases would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-10), for the reasons described in

Section 4.5.3.1 *Suspended Sediment* and Section 4.5.3.2 *Bed Elevation and Grain Size Distribution*. Because there would not be a substantial short-term decrease in steelhead abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to steelhead under the Two Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on steelhead In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the Two Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including steelhead. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Two Dam Removal Alternative on steelhead by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6. *Algal Toxins*, in the long term the Two Dam Removal Alternative would increase the amount of habitat available to steelhead and improve water quality and bedload characteristics in the mainstem Klamath River in the same manner as the Proposed Project. Overall, these changes could result in a substantial increase the abundance of steelhead populations in the long term. Therefore, the Two Dam Removal Alternative would be beneficial for steelhead in the long term.

Significance

No significant impact for steelhead populations in the short term

Beneficial for steelhead populations in the long term

Potential Impact 3.3-11 Effects on the Pacific lamprey population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on Pacific lamprey in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-11), with a few subtle differences. As described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, impacts on Pacific lamprey from sediment releases would be similar to the Proposed Project, as well as water quality, and algal toxins. The same habitat expansion (approximately 80 miles) expected under the Proposed Project (as described in Section 3.3.5.8 *Aquatic Habitat*) would occur, with the exception of habitat under Copco No. 2 Reservoir (0.3 miles) and J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir and unlikely to be used by Pacific Lamprey. Based on the 80 miles of Pacific lamprey habitat estimated upstream of Iron Gate Dam (Section 3.3.5.8 *Aquatic Habitat*), the 3.8 miles that would remain inundated by Copco No. 2 and J.C. Boyle reservoirs rather than revert to riverine habitat under the Two Dam Removal Alternative is unsubstantial (< 5 percent of newly accessible habitat). Juvenile lamprey would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.5.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at Copco No. 2 and J.C. Boyle dams is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles at each facility, or 4 percent cumulative mortality for migrants that use both facilities.

The short-term impacts on Pacific lamprey from sediment releases would be the same under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-11), for the reasons described in Section 4.5.3.1 *Suspended Sediment* and Section 4.5.3.2 *Bed Elevation and Grain Size Distribution*. Because there would not be a substantial short-term decrease in Pacific lamprey abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to Pacific lamprey under the Two Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on Pacific lamprey In the short term, aquatic resource measure AR-1 (Mainstem Spawning) would occur under the Two Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on Pacific lamprey. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measure AQR-1, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Two Dam Removal Alternative on Pacific lamprey by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6. *Algal Toxins*, in the long term the Two Dam Removal Alternative would increase the amount of habitat available to Pacific lamprey and improve water quality and bedload characteristics in the mainstem Klamath River in the same manner as the Proposed Project. Overall, these changes could result in a substantial increase the abundance of Pacific lamprey populations in the long term. Therefore, the Two Dam Removal Alternative would be beneficial for Pacific lamprey in the long term.

Significance

No significant impact for Pacific lamprey in the short term

Beneficial for Pacific lamprey in the long term

Potential Impact 3.3-12 Effects on the green sturgeon population due to short-term sediment releases and long-term changes in habitat quality due to dam removal.
Southern DPS Green Sturgeon may enter the Klamath River Estuary to forage during the summer months. They would not be present when the most severe effects of dam removal are occurring and are not expected to be affected by the Two Dam Removal Alternative. The remainder of this section focuses on the effects of the Two Dam Removal Alternative on the Northern Green Sturgeon DPS. Northern Green Sturgeon

do not occur upstream of Ishi Pishi Falls and would not be affected by Two Dam Removal Alternative impacts that do not extend downstream past these falls. Potential impacts on green sturgeon in California would be the same under the Two Dam Removal Alternative as those described for the Proposed Project in the short- and long-term (Potential Impact 3.3-12). Because there would not be a substantial short-term decrease in green sturgeon abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the green sturgeon population under the Two Dam Removal Alternative in the short term.

For reasons described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6. *Algal Toxins*, in the long term the Two Dam Removal Alternative would result in improvements in flow regime, water quality, temperature variation, and algal toxins which could affect Northern Green Sturgeon in the same manner as the Proposed Project. Because there would not be a substantial long-term decrease in green sturgeon abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the green sturgeon population under the Two Dam Removal Alternative in the long term.

Significance

No significant impact for green sturgeon in the short or long term

Potential Impact 3.3-13 Effects on Lost River and shortnose sucker populations due to short- and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on Lost River and shortnose suckers in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-13), with a few notable differences. For reasons described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, impacts on Lost River and shortnose suckers in Upper Klamath Lake, interactions with anadromous fish, and from conversion of Lower Klamath Project reservoir habitat to riverine habitat would be similar to the Proposed Project. Lost River and shortnose suckers currently occur within all Lower Klamath Project reservoirs, except Copco No. 2 due to its small size (Desjardins and Markle 1999). Therefore, while under the Proposed Project all Lower Klamath Project reservoir habitat currently supporting Lost River and shortnose suckers would be removed (2,347 acres), under the Two Dam Removal Alternative habitat would remain in J.C. Boyle Reservoir (420 acres). Most of the reservoir habitat (82 percent), and the preponderance of the Lost River and shortnose sucker populations in the Hydroelectric Reach is within Iron Gate and Copco No. 1 reservoirs.

Overall, the short-term impact of the Two Dam Removal Alternative would be very similar to the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-13), with the exception of those Lost River and shortnose sucker individuals that are able to remain within J.C. Boyle Reservoir habitat. All individual suckers occurring within Iron Gate and Copco No. 1 reservoirs would likely be lost within dam removal year 2; however, these individuals are not considered to substantially contribute to the achievement of conservation goals or recovery, since little or no reproduction occurs downstream from Keno Dam (Buettner et al. 2006), and there is no potential for interaction with upstream populations (Hamilton et al. 2011). Based on the best available estimates of Lost River and shortnose sucker abundance in the Lower Klamath Project excluding J.C. Boyle and Copco No. 2 reservoirs, there are likely fewer than 1,000 adult suckers of both species (USFWS 2012, Desjardins and Markle 1999), with a combined suitable sucker area of less than 2,500 acres. The populations in Upper Klamath Lake are estimated at 50,000 to 100,000 Lost River sucker (USFWS 2013b), and up to 25,000 shortnose suckers (USFWS 2013c), within around 79,000 acres of suitable habitat in Upper Klamath Lake and connected water bodies. Therefore, a loss of the suckers in Lower Klamath Project reservoirs (excluding J.C. Boyle and Copco No. 2 reservoirs) represents around less than 1.5 percent of the total sucker population, and a loss of less than 3.5 percent of the total suitable sucker habitat. Based on no predicted substantial (< 1.5 percent) short-term decrease in Lost River and shortnose suckers' abundance of a year class, or substantial decrease in habitat quality or quantity (<1.5 percent), the Two Dam Removal Alternative would not cause a significant impact to the Lost River and shortnose sucker populations in the short term.

For the reasons described above in Section 4.5.3.7 *Aquatic Habitat*, in the long term reservoir removal associated with dam removal under the Two Dam Removal Alternative would eliminate habitat availability and affect Lost River and shortnose suckers in Iron Gate and Copco No. 1 reservoirs. All individual suckers occurring within these reservoirs would likely be lost within the short term and would not be replaced in the long term. However, as described above, these individuals are not considered to substantially contribute to the achievement of conservation goals or recovery of the populations (Hamilton et al. 2011). Because there would not be a substantial long-term decrease in Lost River and shortnose suckers abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the Lost River and shortnose sucker populations under the Two Dam Removal Alternative in the long term.

In addition, and as described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-13), although this EIR finds no significant impact on Lost River and shortnose suckers in the short term or long term, aquatic resource measure AR-6 (Suckers) would occur under the Two Dam Removal Alternative, which would further reduce the potential for effects of reservoir removal.

Significance

No significant impact for Lost River and shortnose sucker populations in the short term

No significant impact for Lost River and shortnose sucker populations in the long term

Potential Impact 3.3-14 Effects on the redband trout population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on redband trout in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-14), with a few notable differences. As described in Section 4.5.3.1 *Suspended Sediment* through Section 4.5.3.6 *Algal Toxins*, impacts on redband trout from water quality would be similar to the Proposed Project, as well as algal toxins. Redband trout would also be affected by the reintroduction of anadromous fish, including the potential for competition, predation, and exposure to disease in the same manner as described for the Proposed Project (Potential Impact 3.3-14), since these result from restored habitat access of anadromous salmonids that would not differ between the Proposed Project and the Two Dam Removal Alternative.

Suspended and bedload sediment effects would differ from those described for the Proposed Project. Redband trout are distributed upstream of Iron Gate Dam, and therefore under the Proposed Project the only impacts these individuals would experience from sediment releases would be downstream of J.C. Boyle or downstream of Copco No.2). Therefore, despite the relatively small volume of sediment stored in J.C. Boyle Reservoir (and even less in Copco No. 2), impacts of sediment release on redband trout that would occur under the Proposed Project would be substantially less under the Two Dam Removal Alternative.

As described in Section 4.5.3.7 *Aquatic Habitat*, conversion of Lower Klamath Project reservoir habitat to riverine habitat would be similar to the Proposed Project, with the exception of Copco No. 2 and J.C. Boyle reservoirs. Under the Two Dam Removal Alternative redband trout would benefit from changes in hydropower operations, and from the conversation of 17.7 miles of reservoir habitat to riverine habitat, in the same manner as for the Proposed Project. However, 3.8 miles of mainstem and tributary habitat would continue to be inundated by Copco No. 2 and J.C. Boyle reservoirs. It is anticipated that under the Two Dam Removal Alternative this habitat would continue to support an adfluvial redband trout population. As described in Section 4.5.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at Copco No. 2 and J.C. Boyle dams is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles at each facility, or 4 percent cumulative mortality for migrants that use both facilities.

Because there would not be a substantial short-term decrease in redband trout abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the redband trout population under the Two Dam Removal Alternative in the short term. Based on a long-term substantial increase in redband trout habitat quality and quantity, the Two Dam Removal Alternative would be beneficial for redband trout in the long term.

Significance

No significant impact for redband trout in the short term

Beneficial for redband trout in the long term

Potential Impact 3.3-17 Effects on species interactions between introduced resident fish species and native aquatic species due to short- and long-term changes in habitat quality and quantity due to dam removal.

Introduced fish species threaten the diversity and abundance of native fish species through competition for resources, predation, interbreeding with native populations, and causing potential physical changes to the invaded habitat (Moyle 2002). Potential impacts on species interactions between introduced resident fish species and native aquatic species ("species interactions") in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14), with a few notable differences. As described for the Proposed Project, implementation of the Two Dam Removal Alternative would eliminate reservoir habitat associated with Iron Gate and Copco No. 1 reservoirs, and thus the abundance of introduced resident species would decline substantially (Buchanan et al. 2011a), providing a benefit to native aquatic species. However, the Two Dam Removal Alternative would retain the habitat supporting non-native fish species associated primarily with J.C. Boyle Reservoir. As described in Section 3.3.2.1 *Aquatic Species* *[non-native fish species]*, non-native fish species would continue to occur in J.C. Boyle Reservoir, including yellow perch and bass species (Copco No. 2 is too small to provide substantial habitat for non-native species). Juvenile salmonids and lamprey would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018). However, in restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (NMFS 2006a). In addition, the majority of the non-native species are within Iron Gate and Copco No. 1 reservoirs, which support popular recreational fisheries for yellow perch and bass. Therefore, species interactions under the Two Dam Removal Alternative would be substantially improved relative to existing conditions, albeit to a lesser degree than under the Proposed Project. This effect would be beneficial for native aquatic species in the short and long term.

Significance
Beneficial for the effects of introduced resident fish species on aquatic species in the short term and long term

Potential Impact 3.3-19 Effects on freshwater mollusks populations due to short-term sediment releases and long-term changes in habitat quality due to dam removal.
Potential impacts on freshwater mollusks in California would be similar under the Two Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-19), with a few subtle differences. As described in Section 4.5.3.1 *Suspended Sediment*, impacts on freshwater mollusks from sediment releases would be similar to the Proposed Project. Based on the distribution of freshwater mollusks primarily downstream of Iron Gate dam (summarized in Section 3.3.5.9, Potential Impact 3.3-14), the impacts of the Two Dam Removal Alternative would be the same as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14) with one exception. The Proposed Project would have the most substantial impact on the floater mussels (*Anodonta spp*.) which occur in the mainstem Klamath River in the Hydroelectric Reach, within Lower Klamath Project reservoirs, in a reach (<15 miles) directly downstream of Iron Gate Dam, and within the Upper Shasta River. *Anodonta spp*. have been found in high abundance within J.C. Boyle Reservoir as recently as summer 2018 (Troy Brandt, River Design Group, pers. comm., November 2018). Therefore, under the Two Dam Removal Alternative the *Anodonta spp.* would remain unaffected within a portion of their range in J.C. Boyle Reservoir and Upper Shasta River. Therefore, while the impacts to other species of freshwater mollusks would be the same under the Proposed Project (not significant), impacts to the *Anodonta spp*. would be less substantial under the Two Dam Removal Alternative than under the Proposed Project. However, impacts the *Anodonta spp.* would still occur under the Two Dam Removal Alternative in the mainstem Klamath River (primarily downstream of Iron Gate Dam) as described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14), and based on predicted substantial short-term decrease in *Anodonta spp.* abundance of a year class, there would be a significant impact to the *Anodonta spp.* population under the Two Dam Removal Alternative in the short term.

However, the Two Dam Removal Alternative includes aquatic resource measure AR-7 (Freshwater Mussels) to reduce the short-term effects of sediment transport during dam removal on *Anodonta spp.*, as described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14). Under the Proposed Project this salvage and relocation plan would consider sites for translocation downstream from the Trinity River confluence (RM 43.4), and between J.C. Boyle Dam (RM 230.6) and Copco No. 1 Reservoir (RM 209.0). These areas would have less impact from increased SSCs but would not be completely protected from short-term effects. The areas downstream of the Trinity River confluence do not currently support *Anodonta spp*. and are unlikely to in the future (Davis et al. 2013). However, under the Two Dam Removal Alternative *Anodonta spp*. could be salvaged from the reach downstream of Iron Gate Dam and relocated to J.C. Boyle Reservoir, which does support suitable *Anodonta spp*. habitat. Therefore, with aquatic resource measure AR-7, there would likely not be a substantial reduction in the abundance of *Anodonta spp.* species in the short term, and impacts would be not significant with for *Anodonta spp.* in the short term.

Significance

No significant impact for *M. falcata, G. angulate, or Anodonta spp.* in the short or long term

No significant impact for freshwater clams in the short or long term

4.5.4 Phytoplankton and Periphyton

4.5.4.1 Phytoplankton

Short-term mobilization of J.C. Boyle Reservoir sediment deposits would not occur under the Two Dam Removal Alternative (see Section 4.5.2.2 *Suspended Sediments*), thus there would be no short-term increase in sediment-associated nutrients downstream of J.C Boyle Dam (see Section 4.5.2.3 *Nutrients*). There would be no change in the short term sediment-associated nutrients in the Hydroelectric Reach or downstream under the Two Dam Removal Alternative compared to under the Proposed Project due to keeping Copco No. 2 Dam in place, since that dam with its small size and short residence time is not expected to intercept or retain appreciable amounts of sediment or the associated nutrients during drawdown. While there would be a short-term increase in sediment-associated nutrients from release of Copco No. 1 and Iron Gate reservoir deposited sediments and associated nutrients in the Hydroelectric Reach, as well as in the Middle Klamath River, Lower Klamath River, and Klamath River Estuary during reservoir drawdown (see Section 4.5.2.3 *Nutrients*), minimal deposition of fine suspended sediments, including the associated nutrients, would occur in the river channel and the estuary (Stillwater Sciences 2008; USBR 2012). Thus, the short-term increase in nutrients would be limited to the time period when sediment deposits are being transported through the Klamath River. The drawdown of Copco No. 1 and Iron Gate reservoirs and release of these nutrients also would occur during winter months when the rates of phytoplankton growth and reproduction along with the rates of nutrient transformations by microbes (e.g., nitrification and denitrification) are relatively low, so the ability of phytoplankton to use sediment-associated nutrients mobilized during reservoir drawdown would be low (see Potential Impact 3.4-1). Sediment released during reservoir drawdown under the Two Dam Removal Alternative also would increase suspended sediment concentrations and water turbidity (see also Potential Impact 3.2-3), limiting light availability for phytoplankton photosynthesis and further reducing the potential for additional phytoplankton growth and reproduction. Under the Two Dam Removal Alternative, the sediment-associated nutrients would be less than under the

Proposed Project since no J.C. Boyle sediment-associated nutrients would be released, but the overall impact would be the same in both the Two Dam Removal Alternative and the Proposed Project. The sediment-associated nutrients would not be likely to stimulate phytoplankton growth or reproduction that would lead to an increase spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton, so there would be no significant impact.

With respect to potential long-term impacts, J.C. Boyle Reservoir does not support low mixing conditions or thermal stratification that create optimal habitat for phytoplankton growth or reproduction under existing conditions due to its shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days at average flows) and it would not do so under the Two Dam Removal Alternative. Peaking power generation flows are released in the late afternoons and early evenings to meet high power demand, and J.C. Boyle Reservoir refills during the night when power demand is minimal. Daily fluctuations in the reservoir water level under existing operations increases mixing in the reservoir, making the reservoir slightly less suitable habitat for phytoplankton during the season of maximum phytoplankton and cyanobacteria (blue-green-algae) growth in the system. Ceasing peaking power generation flows would reduce daily reservoir water level fluctuations in J.C. Boyle Reservoir because the facility would no longer be operated to draw on reservoir storage to support daily peaks in hydropower production when there is not sufficient river flow for peak production (3,000 cfs), as occurs during the summer and fall low flow period under existing conditions. However, the residence time of J.C. Boyle Reservoir without peaking operations would still be short (i.e., on the order of one to three days), so leaving this dam in place and ceasing peaking flows would not change long-term phytoplankton growth or reproduction and thus it would not change the spatial extent, temporal duration, or concentration of nuisance and/or noxious phytoplankton blooms, including blue-green algae, to the degree that new or further impairment of designated beneficial uses would occur.

Similarly, Copco No. 2 Reservoir has no active storage, a negligible hydraulic residence time (i.e., less than one day) (USBR 2012), and does not thermally stratify, such that the reservoir under existing conditions does not support conditions for the growth of phytoplankton in the epilimnion, unlike the larger Copco No. 1 and Iron Gate reservoirs (see 3.2.2.1 *Overview of Water Quality Processes in the Klamath Basin*). Under the Two Dam Removal Alternative, Copco No. 2 Reservoir remaining in place would not affect the spatial extent, temporal duration, and concentration of nuisance and/or noxious phytoplankton species within the Hydroelectric Reach or downstream reaches since it would continue to not support suitable habitat for phytoplankton growth, reproduction, or blooms.

Copco No. 1 and Iron Gate reservoirs currently support growth conditions for toxin-producing nuisance phytoplankton species such as *Microcystis aeruginosa*, with these two reservoirs serving as the primary habitat for blue-green algae in the Hydroelectric Reach. Thus, the removal of Copco No. 1 and Iron Gate reservoirs under the Two Dam Removal Alternative would eliminate the main habitat for toxin-producing nuisance phytoplankton and reduce the long-term spatial extent, temporal duration, and concentration of nuisance and/or noxious phytoplankton species relative to existing conditions, consistent with the Proposed Project. The elimination of Copco No. 1 and Iron Gate reservoirs would be beneficial in the Hydroelectric Reach downstream of Copco No. 1 Reservoir.

Because seasonal phytoplankton blooms are primarily internally generated in Copco No. 1 and Iron Gate reservoirs, removal of these reservoirs under the Two Dam Removal Alternative would also decrease or eliminate the long-term downstream transport of nuisance and/or noxious phytoplankton species and their associated toxins from Copco No. 1 and Iron Gate reservoirs into the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment.

In summary, relative to existing conditions, the potential impacts and impacts of the Two Dam Removal Alternative on phytoplankton would be the same as or similar to those described for the Proposed Project, as follows:

- There would be no short-term change in phytoplankton growth and reproduction from existing conditions in the Hydroelectric Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir due to mobilization of sediment-associated nutrients from J.C. Boyle Reservoir because this reservoir and its sediment deposits would remain in place (Potential Impact 3.4-1).
- While there would be short-term increases in sediment-associated nutrients downstream of Copco No. 1 Dam due to the release of sediments currently trapped behind the Copco No. 1 and Iron Gate dams, Copco No. 2 remaining in place would not alter the short-term sediment-associated nutrients conditions compared to the Proposed Project and the short-term increases in sediment-associated nutrients would not increase the spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton species, including blue-green algae, in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, and the Klamath River Estuary such that there would be new or further impairment of designated beneficial uses; thus there would be no significant impact in the short term (Potential Impact 3.4-1).
- There would be no significant impact in the long term from J.C. Boyle Dam remaining in place and ceasing peaking power generation flows on the spatial extent, temporal duration, transport, and/or concentration of nuisance and/or noxious phytoplankton species and concentrations of algal toxins because J.C. Boyle Reservoir would not support habitat that would promote phytoplankton blooms under the Two Dam Removal Alternative similar to under existing conditions (Potential Impact 3.4-2).
- Copco No. 2 remaining in place would not alter the phytoplankton conditions in the Hydroelectric Reach since it does not support habitat conditions for the growth or reproduction of phytoplankton, including blue-green algae. However, the long-term reduction in the spatial extent, temporal duration, transport, and/or concentration of nuisance and/or noxious phytoplankton species and concentrations of algal toxins due to elimination of Copco No. 1 and Iron Gate reservoir habitats would be beneficial for the Hydroelectric Reach, Middle and Lower Klamath River, and Klamath River Estuary (Potential Impact 3.4-2). There would be no significant impact for the Pacific Ocean nearshore environment (Potential Impact 3.4-2).

4.5.4.2 Periphyton

Short-term mobilization of J.C. Boyle Reservoir sediment deposits would not occur under the Two Dam Removal Alternative, thus there would be no short-term increase in sediment-associated nutrients downstream of J.C Boyle Dam. There would be no change in the short term sediment-associated nutrients in the Hydroelectric Reach or downstream under the Two Dam Removal Alternative compared to under the Proposed Project due to keeping Copco No. 2 Dam in place, since it is not expected to intercept or retain appreciable amounts of sediment or the associated nutrients during drawdown (see Section 4.5.2.2 *Suspended Sediments* and Section 4.5.2.3 *Nutrients*). While there would be a short-term increase in sediment-associated nutrients between Copco No. 1 Reservoir and Iron Gate Dam in the Hydroelectric Reach, as well as in the Middle Klamath River, Lower Klamath River, and Klamath River Estuary during reservoir drawdown, minimal deposition of fine suspended sediments, including the associated nutrients, would occur in the river channel and the estuary (Stillwater Sciences 2008; USBR 2012). Thus, the short-term increase in nutrients would be limited to the time period when sediment deposits are being transported through the Klamath River. The drawdown of Copco No. 1 and Iron Gate reservoirs and release of these nutrients would occur during winter months when the rates of periphyton growth and reproduction along with the rates of nutrient transformations by microbes (e.g., nitrification and denitrification) are relatively low due to less light availability for photosynthesis and lower water temperatures. As a result, the ability of periphyton to use sediment-associated nutrients would be limited and there would not be an increase in periphyton growth or reproduction during this period, even though additional nutrients would be available due to the release of sediments trapped behind the Lower Klamath Project dams. Light limitation from high concentrations of suspended sediments in the water (Potential Impact 3.2-3) would also reduce any potential for nuisance levels of periphyton growth during reservoir drawdown. Additionally, high river flows during the winter drawdown period and late spring storm events would result in greater sediment movement and scouring, which would greatly limit, if not eliminate, the area of the streambed that periphyton can establish to grow during this period. Thus, the Two Dam Removal Alternative would not be likely to stimulate an increase in periphyton growth or reproduction and result in an increase in the spatial extent, temporal duration, or biomass of nuisance periphyton species that causes a new or further impairment of designated beneficial uses, similar to the Proposed Project.

Under the Two Dam Removal Alternative, J.C. Boyle Reservoir would remain in place and peaking power generation and release of recreation flows would cease from J.C. Boyle Dam, so there would be less artificial diel temperature variation during summer and early fall in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir, similar to the Proposed Project (see also Potential Impact 3.2-1). While J.C. Boyle retains relatively little nutrients under existing conditions (see Appendix C, Section C.3.1.1 *Hydroelectric Reach*), nutrient conditions in this reach would be the same under the Two Dam Removal Alternative as under existing conditions since there would be no change in nutrient interception or retention with J.C. Boyle Dam remaining in place. The less diel temperature variations and slight decrease in the maximum water temperature in this reach is not anticipated to affect periphyton colonization. Additionally, the generally high gradient and velocity in the J.C. Boyle Peaking Reach does not currently support excessive periphyton mats and it is not anticipated this reach would support excessive periphyton mats under lower flows once peaking and recreation flows cease. In the short term and long term, increases in periphyton biomass from elimination of peaking and recreation flows along with the change in water temperature in this reach are expected to be limited under the Two Dam Removal Alternative and any potential increase in periphyton would not result in new or further impairment of designated beneficial uses. Nutrient reduction measures in California's Lower Lost River TMDLs and Klamath River TMDLs could, in the long term, further minimize colonization of periphyton mats in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir. However, the measures necessary to achieve significant reductions are, at this point, unknown.

Further downstream in the Hydroelectric Reach, periphyton growth in low-gradient channel margin areas in the footprints of Copco No. 1 and Iron Gate reservoirs could increase on a seasonal basis following dam removal because removal of those two reservoirs would provide additional low-gradient habitat suitable for periphyton assemblages. Periphyton growth would not be likely to be supported in the approximately 0.3 miles of Copco No. 2 Reservoir due to relatively deep water (i.e., up to 28 feet [USBR 2012]), so retaining Copco No. 2 Dam under the Two Dam Removal Alternative and the reduction in suitable periphyton habitat would slightly reduce the extent of periphyton growth compared to the Proposed Project. Dam removal construction and restoration activities in dam removal year 2 and additional sediment transport and scour during winter post-dam removal year 1 may inhibit some periphyton growth in the Hydroelectric Reach in the Copco No. 1 and Iron Gate reservoir footprints, but, overall, periphyton would be expected to begin colonizing the newly created suitable habitat within the short term and would continue in the long term. While retaining Copco No. 2 Reservoir would reduce the available periphyton habitat compared to the Proposed Project, the growth of periphyton within the newly created low-gradient channel margin areas in the Copco No. 1 and Iron Gate reservoirs' footprint conservatively would be a significant impact similar to the Proposed Project (Potential Impact 3.4-4) due to potential increases in nuisance periphyton within the footprints of those two reservoirs. The response of periphyton in the river is subject to many competing processes that could either accelerate or hinder periphyton growth and potential increases in nuisance periphyton (i.e., *Cladophora* sp.) extent, duration, and biomass. In the long term, improvements (i.e., reductions in biomass) are expected from several processes such as scour, long term nutrient reductions stemming from TMDL actions, and in-stream retention processes, whereas improvements could be diminished by processes such as reduced nutrient retention from the reservoirs or climate change. While the growth of nuisance periphyton along channel margin areas is not expected to contribute algal toxins that would impair water quality, the degree to which designated beneficial uses would be impaired due to an increase in nuisance periphyton species (i.e., *Cladophora* sp.) in the newly formed low-gradient channel margin areas of the Hydroelectric Reach is not fully understood. The implications of potential changes in periphyton biomass and community composition on dissolved oxygen and the spread of fish disease are described in Section 3.2.5.4 *Dissolved Oxygen* and Section 3.3.5.5 *Fish Disease and Parasites*, respectively.

Periphyton are a natural component of river ecology and they are an important element of aquatic food webs. The establishment and growth of periphyton, including nuisance periphyton species, along the margins of the newly created low gradient river channel is a natural process. While processes that influence periphyton establishment and growth have been identified (e.g., light availability, nutrient availability, water temperature, seasonal flow variations, sediment transport), variations in these processes within the Hydroelectric Reach of the Klamath River after dam removal would not completely prevent the potential for growth of nuisance periphyton species along the margins of the newly created low gradient river channels. In the reservoir areas of the Hydroelectric Reach that would become the newly created low gradient habitat, there is no periphyton since it is not suitable habitat. No mitigation measure would completely eliminate the potential for establishment and growth of periphyton or specifically nuisance periphyton within these areas. As such, there are no mitigation measures that can be proposed to significantly avoid or minimize this impact and reduce the impact to less than significant.

In summary, relative to existing conditions, the potential impacts of the Two Dam Removal Alternative on periphyton would be the same as or similar to those described for the Proposed Project, as follows:

- There would be no significant impact in the short term from changes in periphyton growth compared to existing conditions due to mobilization of sediment-associated nutrients from J.C. Boyle Reservoir (Potential Impact 3.4-3) because this reservoir and its sediment deposits would remain in place.
- Copco No. 2 Dam remaining in place would not alter the short-term sediment-associated nutrients during drawdown and periphyton usage of sediment-associated nutrients mobilized from Copco No. 1 and Iron Gate reservoirs would be limited due to lower light levels reducing photosynthesis for periphyton growth and higher flows scouring periphyton from the streambed during winter and early spring. Thus, there would not be an increase in the spatial extent, temporal duration, or biomass of nuisance periphyton species in the Hydroelectric Reach downstream of Copco No. 1, the Middle and Lower Klamath River, or the Klamath River Estuary that would result in a new or further impairment of designated beneficial uses (Potential Impact 3.4-3), and there would be no significant impact.
- There would be no short-term or long-term increase in nuisance periphyton growth that results in new or further impairment of designated beneficial uses in the Hydroelectric Reach from J.C. Boyle Dam to Copco No. 1 Reservoir, including the Oregon-California state line, due to increased nutrients or ceasing of peaking flows at J.C. Boyle (Potential Impact 3.4-4), so there would be no significant impact.
- While Copco No. 2 Dam remaining in place would reduce the available periphyton habitat compared to the Proposed Project, there could be a short-term and/or long-term increase in nuisance periphyton growth that would result in new or further impairment of designated beneficial uses in the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam due to an increase in nutrients and available low-gradient channel margin habitat from conversion of the Copco No. 1 and Iron Gate reservoir areas to a free-flowing river (Potential Impact 3.4-4) and if this increase were to occur, it would be a significant and unavoidable impact.
- There would be no long-term increase in biomass of nuisance periphyton that would result in new or further impairment of designated beneficial uses in the Middle Klamath River, Lower Klamath River, and Klamath River Estuary due to increased nutrient availability from upstream dam removal under the Two Dam Removal Alternative similar to the Proposed Project (Potential Impact 3.4-5), so there would be no significant impact.

4.5.5 Terrestrial Resources

Although short-term dam deconstruction activities would not occur for Copco No. 2 Dam under the Two Dam Removal Alternative, deconstruction of Copco No. 1 and Iron Gate dams and associated facilities, and construction of upstream and downstream fish passage facilities and a new day use area near Copco No. 2 Dam would occur, and thus the level of overall construction activities in the Hydroelectric Reach in California would be only slightly less than those described under the Proposed Project. Therefore, in general the Two Dam Removal Alternative would have slightly less short-term potential impacts on vegetation communities, culturally significant species, special status species, wildlife corridors and habitat connectivity, as those described for the Proposed Project (see Section 3.5.5 *[Terrestrial Resources] Potential Impacts and Mitigation]*. The mitigation measures and recommended terrestrial measures would be the same as those identified for the Proposed Project. Long-term potential impacts and any short-term potential impacts that would be different under the Two Dam Removal Alternative than the Proposed Project are discussed below.

In the long term, since Copco No. 2 Dam and Reservoir would remain under the Two Dam Removal Alternative, the reduction of existing wet habitat that currently supports the following wetland vegetation communities would not occur and there would be no significant impact compared with existing conditions:

- Palustrine Scrub-shrub Wetland and Palustrine Forested Wetland on the southern slope of Copco No. 2 Dam.
- Small, local patches of Palustrine Emergent Wetland supported by water leaks from the Copco No. 2 penstock.

While retaining the existing wet habitat at Copco No. 2 Reservoir would reduce potential long-term impacts to these wetland and riparian vegetation communities described under the Proposed Project and thus may be relatively beneficial, the proposed acreage (150 acres) for restored riparian and wetland vegetation under the Proposed Project is well above the total acreage that would potentially be impacted (68 acres), such that the policy of no net loss compared with existing conditions would be achieved regardless of whether the Copco No. 2 Dam remains under the Two Dam Removal Alternative.

Leaving Copco No. 2 Dam in place under the Two Dam Removal Alternative would avoid potential long-term impacts to the rock talus habitat present just downstream of the dam, and there would be no significant impact on Forest Service or BLM special-status terrestrial invertebrates Oregon shoulderband, Trinity shoulderband, Siskiyou shoulderband, and Tehama chaparral compared with existing conditions. However, since suitable habitat is present in numerous locations throughout the Primary Area of Analysis for terrestrial resources (Appendix G), any impact on this specific area would not be expected to affect any federal species of special concern at a population level, if present (Potential Impact 3.5-10), regardless of whether the Copco No. 2 Reservoir remains under the Two Dam Removal Alternative.

While Copco No. 1 and Iron Gate dams and facilities would be fully removed under this alternative, the Copco No. 2 Dam and facilities and the J.C. Boyle Dam and facilities would remain in place, which would slightly reduce construction activities relative to the Proposed Project. Short-term construction-related noise would still be generated in California due to removal of the Copco No. 1 and Iron Gate dams and associated facilities and installation of fish passage at the Copco No. 2 Dam. Retaining Copco No. 2 structures under this alternative would not reduce noise-related impacts on special-status bats or birds to a less than significant level. Although this alternative would remove structures that also support known bat roosts, including maternity roosts (e.g., Copco No. 1 Dam – C-12 Gatehouse, Copco No. 1 Powerhouse, and Copco No 1. Diversion Tunnel), some of the structures that would be retained (i.e., Copco No. 2 Powerhouse and vacant house #21601) are known to support maternity colonies (see Section 3.5.5.3 *Special-status Species and Rare Natural Communities*). Thus, relative to the Proposed Project, the Two Dam Removal Alternative would reduce the potential for long-term population-level impacts due to the removal of large maternity colonies day roosts and large maternity colonies that may be present (Potential Impact 3.5-15). While there would be no significant impact to maternity roosts associated with the Copco No. 2 structures compared with existing conditions, there would still be a significant impact compared to existing conditions for this alternative due to the removal of maternity roosts associated with the Copco No. 1 structures.

Retaining Copco No. 2 facilities (reservoir, dam, penstocks, buildings) under the Two Dam Removal Alternative would result in no change from existing conditions with respect to wildlife corridors and habitat connectivity associated with these structures. Effects on wildlife corridors and habitat connectivity would be marginally less beneficial in terms of providing enhanced migration opportunities as those described for the Proposed Project because Copco No. 2 facilities would remain and may continue to impede wildlife migration. The greatest length of parallel steel penstocks that would remain at Copco No. 2 Dam under this alternative is approximately 410 feet and the length of wooden-stave penstock that would remain is approximately 1,330 feet. The Copco No. 2 powerhouse and intake structure do not present a migration barrier under existing conditions such that retaining these features would not represent a change from existing conditions. While retaining Copco No. 2 Dam and Reservoir under the Two Dam Removal Alternative would continue to impede upstream movement of amphibians and reptiles, as described for the Proposed Project, removing Copco No. 1 and Iron Gate dams and reservoirs would benefit some terrestrial species by eliminating barriers to migration (Potential Impacts 3.5-24, 3.5-30, 3.5-31) and overall the effect of the Two Dam Removal Alternative on wildlife corridors and habitat connectivity would be beneficial.

In summary, relative to existing conditions, the potential long-term impacts of the Two Dam Removal Alternative on terrestrial resources would be different from those described for the Proposed Project, as follows:

- Long-term reduction of existing wet habitat that supports the aforementioned wetland vegetation communities on the southern slope of Copco No. 2 Dam and associated with the Copco No. 2 penstock (Potential Impact 3.5-2) would not occur and there would be no significant impact.
- Long-term disturbance of potentially suitable rock talus habitat for the terrestrial invertebrates Oregon shoulderband, Trinity shoulderband, Siskiyou shoulderband, and Tehama chaparral located just downstream of Copco No. 2 Dam (Potential Impact 3.5-9) would not occur and there would be no significant impact.
- Long-term impacts to small day roosts and large maternity colonies in or near the Copco No. 2 Powerhouse and other Copco No. 2 facility structures (Potential Impact 3.5-15) would not occur and there would be no significant impact.

4.5.6 Flood Hydrology

The Two Dam Removal Alternative would have the same potential impacts on flood hydrology as those described for the Proposed Project (Potential Impacts 3.6-1 through 3.6-6). This is because Copco No. 2 Reservoir has no active storage, J.C. Boyle Reservoir has a relatively small storage capacity (2,267 acre-feet total storage; 1,724 acre-feet active storage; see Table 3.6-4) and does not attenuate flood flows in the Area of Analysis, and PacifiCorp does not operate either reservoir for flood control. Therefore, leaving Copco No. 2 and J.C. Boyle reservoirs in place would not affect flood hydrology compared to the Proposed Project and there would be no significant impacts for Potential Impacts 3.6-1, 3.6-2, and 3.6-4 through 3.6-6. There would be significant and unavoidable impacts related to exposing structures to a substantial risk of damage due to flooding downstream of the location of Iron Gate Dam (Potential Impact 3.6-3).

4.5.7 Groundwater

The Two Dam Removal Alternative would have the same potential impacts on groundwater as those identified under the Proposed Project (Potential Impacts 3.7-1 and 3.7-2). This is because Copco No. 2 Reservoir has no active storage and J.C. Boyle is more than 20 river miles upstream of the Area of Analysis, such that leaving these reservoirs in place would not affect groundwater levels or wells immediately adjacent (potentially extending up to a mile from the reservoirs under certain conditions) to Copco No. 1 and Iron Gate reservoirs compared to the Proposed Project. Removal of Copco No. 1 and Iron Gate reservoirs under the Two Dam Removal Alternative would result in the same effects on groundwater as described for the Proposed Project (Section 3.7.5 *[Groundwater] Potential Impacts and Mitigation*) for the reasons described in Potential Impacts 3.7-1 and 3.7-2, and there would be no significant impacts.

4.5.8 Water Supply/Water Rights

The Two Dam Removal Alternative would have the same potential impacts on water supply/water rights as those identified under the Proposed Project (Potential Impacts 3.8-1 through 3.8-5). This is because Copco No. 2 Reservoir has no active storage, J.C. Boyle Reservoir has a relatively small storage capacity (2,267 acre-feet total storage; 1,724 acre-feet active storage; see Table 3.6-4), and neither reservoir is operated by PacifiCorp as a water supply source, such that leaving these reservoirs in place would not affect water supply/water rights compared to the Proposed Project. Thus, Potential Impacts 3.8-1, 3.8-2, and 3.8-5 under the Proposed Project would be the same under the Two Dam Removal Alternative, and there would be no significant impacts.

Short-term mobilization of J.C. Boyle Reservoir sediment deposits would not occur under the Two Dam Removal Alternative and none of the associated 1,190,000 cubic yards of deposits (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches, although little to no sediment deposition would be expected in the reach between J.C. Boyle Dam and Copco No. 1 Reservoir (USBR 2012). Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*). However, mobilization of reservoir sediment deposits in the much larger Copco No. 1 and Iron Gate reservoirs would still occur under this alternative such that release of stored sediment during reservoir drawdown could still impact water intake pumps downstream from Iron Gate Dam (Potential Impact 3.8-3). This would be a significant impact. Implementation of Mitigation Measure WSWR-1 would be required to result in no significant impact.

The City of Yreka's municipal water supply pipeline would still need to be relocated following drawdown of Iron Gate Reservoir, and there would still be potential for disruption to the City's water supply, as described under the Proposed Project. This would be a significant impact. Implementation of Mitigation Measure WSWR-2 would reduce this potential impact to less than significant.

4.5.9 Air Quality

For the reasons discussed below, potential air quality impacts due to construction activities under the Two Dam Removal Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.9-1 through 3.9-5). Construction activities at J.C. Boyle Dam, regardless of whether these would be for dam removal or fish ladder construction, would occur in Oregon. However, as with the Proposed Project, due to the potential for the emissions generated from construction activity in Oregon to have air quality impacts in Siskiyou County, California, the emissions from construction activity in Oregon are conservatively included in the estimate of total emissions due to construction activity under this alternative.

In California, while short-term dam deconstruction activities would not occur at Copco No. 2 Dam under the Two Dam Removal Alternative, construction of upstream and downstream fish passage facilities and a new day use area near Copco No. 2 Dam would occur, and thus the level of overall construction activities and thus daily emissions of air pollutants (i.e., VOCs, CO, NOx, SOs, PM_{10}, $PM_{2.5}$) in the Hydroelectric Reach in California would be slightly less than those described under the Proposed Project. However, this alternative would still result in air quality levels that exceed the Siskiyou County Air Pollution Control District emissions thresholds for NOx and PM_{10} (Table 4.5-2). If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle and Copco No. 2 dams would be further reduced, however this degree of difference would not be sufficient to result in emissions below the Siskiyou County Air Pollution Control District emissions thresholds for NOx and PM_{10} (Table 4.5-2) and this alternative would result in a significant and unavoidable impact.

Table 4.5-2. Total Uncontrolled Daily Emissions from the Two Dam Removal Alternative.[1]

Project Activity	Daily Emissions (pounds per day)[2]					
	VOC	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Dam and Powerhouse Deconstruction	117	552	620	7	399	225
Restoration Activities	18	60	165	20	3	3
Recreation Facilities	8	45	54	0	13	6
Yreka Water Supply Pipeline Relocation	3	16	18	0	10	3
Total	146	673	**857**	27	**425**	237
Significance Criterion[2]	250	2,500	250	250	250	250

[1] Data from 2012 KHSA EIS/EIR.
[2] Values shown in grey highlight exceed the Siskiyou County Air Pollution Control District's (SCAPCD) thresholds of significance in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants).

Key:
- VOC = volatile organic compounds
- CO = carbon monoxide
- NOx = nitrogen oxides
- SOx = sulfur oxides
- PM_{10} = inhalable particulate matter
- $PM_{2.5}$ = fine particulate matter

This alternative would not include operational changes that would affect air emissions in the long term for implementation of fish ladders and there would be no significant impact (Potential Impact 3.9-1).

If trap and haul facilities were to be constructed instead of fish ladders, peak daily emissions due to construction activities would be less than those described above. Long term trap and haul operations would consist of trapping adult upstream migrants downstream of Copco No. 2 Dam and releasing them in J.C. Boyle Reservoir as an ongoing activity. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Copco No. 2 Dam. Although the exact extent and timing of these ongoing hauling activities is not known, peak daily air quality emissions would be considerably less than those estimated above because it is unlikely that more than ten truck trips per day would be necessary, including a conservative assumption of round trip (i.e., upstream and downstream) hauling for 30 for 40 miles each way between Copco No. 2 Dam and J.C. Boyle Reservoir. Therefore, the long-term potential impact on air quality emissions due to trap and haul operations would be less than significant.

4.5.10 Greenhouse Gas Emissions

For the reasons described below, greenhouse gas (GHG) impacts under the Two Dam Removal Alternative would be the slightly less than those described for the Proposed Project (Section 3.10.5 *[Greenhouse Gas Emissions] Potential Impacts and Mitigation*). Construction activities at J.C. Boyle Dam, regardless of whether these would be for dam removal or fish ladder construction (or trap and haul or some combination of fish passage methods) would occur in Oregon. However, as with the Proposed Project, due to the cumulative nature of GHG emissions, the emissions from construction activity in Oregon are conservatively included in the estimate of total emissions due to construction activity under this alternative. In California, construction activities at Copco No. 1 and Iron Gate dams would still occur and this, combined with construction activities at Copco No. 2 Dam (including fishway construction) and at J.C. Boyle Dam in Oregon, means that the detailed discussion of impacts to GHGs provided in the Proposed Project (Potential Impact 3.10-1) also applies to this alternative. Leaving Copco No. 2 and J.C. Boyle dams in place would not change the potential for a conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs (Potential Impact 3.10-2). Overall, the Two Dam Removal Alternative would result in no significant impacts due to GHG emissions.

If trap and haul facilities were to be constructed instead of fish ladders, greenhouse gas emissions due to construction activities would be less than those described above. Long term trap and haul operations would consist of trapping adult upstream migrants downstream of Copco No. 2 Dam and releasing them in J.C. Boyle Reservoir as an ongoing activity. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Copco No. 2 Dam. Although the exact extent and timing of these ongoing hauling activities is not known, greenhouse gas emissions would be considerably less than those estimated above because it is unlikely that more than ten truck trips per day would be necessary, including a conservative assumption of round trip (i.e., upstream and downstream) hauling for 30 to 40 miles each way between Copco No. 2 Dam and J.C. Boyle Reservoir. Therefore, the long-term potential impact on greenhouse gas emissions due to trap and haul operations would be less than significant.

4.5.11 Geology, Soils, and Mineral Resources

For the reasons discussed below, the Two Dam Removal Alternative would have similar effects on geology, soils, and mineral resources in California as would the Proposed Project (Section 3.11 *Geology, Soils, and Mineral Resources*), with minor differences discussed at the end of this section. Relative to the Proposed Project, leaving J.C. Boyle and Copco No. 2 dams and associated facilities in place would reduce overall construction activities related to dam removal. However, as discussed in Section 4.6.1.1 *Alternative Description*, the Two Dam Removal Alternative also includes construction of a new fish ladder at J.C. Boyle Dam (and removal of the existing one within a similar footprint to the existing ladder) and construction of a fish ladder at Copco No. 2 Dam. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle and Copco No. 2 dams would be further reduced relative to the Proposed Project. While there would potentially be less construction activities resulting in short-term soil disturbance under this alternative than under the Proposed Project, the relative decrease in construction activities under the Two Dam Removal Alternative would not change the potential for impacts compared to existing conditions due to geologic hazards, short-term soil disturbance, hillslope instability, earthen dam embankment instability, or loss of mineral resources and impacts would be the same as those described for the Proposed Project.

In California, any of these potential impacts, under either the Proposed Project or the Two Dam Removal Alternative, would be due to removal and reservoir drawdown activities at Copco No. 1 and Iron Gate dams and associated facilities in California. Thus, there would be no significant impacts due to potential for changes to geologic hazards, short-term soil disturbance, earthen dam embankment instability, and mineral resource availability under the Three Dam Removal Alternative for the reasons described for the Proposed Project (Potential Impacts 3.11-1, 3.11-2, 3.11-4 and 3.11-8).

As with the Proposed Project, implementation of Mitigation Measure GEO-1 would be necessary to reduce the potential impacts resulting from slope failure in reservoir rim areas at Copco No. 1 Reservoir (see Potential Impact 3.11-3). With implementation of Mitigation Measure GEO-1, there would be no significant impacts due to the potential for hillslope instability at Copco No. 1 Reservoir during drawdown and the year following drawdown.

Under the Two Dam Removal Alternative, J.C. Boyle Dam would remain in place and the associated 1,190,000 cubic yards of reservoir sediment deposits (eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would not be eroded or delivered to downstream reaches. The latter would reduce associated short-term erosion and sediment delivery impacts (i.e., sedimentation and bank erosion downstream of Iron Gate Reservoir) that would occur under the Proposed Project, given the relatively smaller volume of sediments in J.C. Boyle Reservoir compared with Copco No. 1 and Iron Gate reservoirs. However, the effect would be relatively small since mobilization of reservoir sediment deposits in the much larger Copco No. 1 and Iron Gate reservoirs would still occur. Further, Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*). Therefore, potential short-term erosion and sediment delivery impacts under the Two Dam Removal Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.11-5 through 3.11-7) and there would be no significant impacts, with the exception of the Middle Klamath River between Iron Gate Dam and Cottonwood Creek where there would be a significant and unavoidable impact (see Potential Impact 3.11-5). In the long term, J.C. Boyle Reservoir would continue accumulating sediment at approximately the rate that it does under existing conditions, which is generally low (see Table 3.11-6).

4.5.12 Historical Resources and Tribal Cultural Resources

Under the Two Dam Removal Alternative, leaving the J.C. Boyle Dam and associated facilities in place would reduce construction activities related to dam removal relative to the Proposed Project; however, it would not decrease the degree of construction activities or the associated impacts to historical and tribal cultural resources in California since J.C. Boyle is located in Oregon. Unlike under the Proposed Project, reservoir drawdown associated with the removal of J.C. Boyle Dam would not occur under the Two Dam Removal Alternative. However, as discussed in Potential Impact 3.12-3, drawdown releases from J.C. Boyle Dam under the Proposed Project would not cause flooding of the river between the dam and Copco No. 1 Reservoir and would not result in short-term erosion or flood disturbance to the numerous prehistoric archaeological riverside sites with habitation debris, house pits and rock features and cemeteries; as well as ethnographic places and other features of the cultural landscape that have been identified as TCRs along this reach of the Klamath River (PacifiCorp 2004, Daniels 2006). Therefore, leaving J.C. Boyle Dam in place under the Two Dam Removal Alternative would have no bearing on the potential for impacts to known or unknown historical and/or tribal cultural resources within this reach and, like the Proposed Project, there would be no significant impact. The potential for flood disturbance further downstream along the Klamath River would not be different under this alternative from that described for the Proposed Project (Potential Impact 3.12-3) since the two largest reservoirs, Copco No. 1 and Iron Gate would still be removed.

Copco No. 1 and Iron Gate dams would be removed under this alternative and potential impacts to the built environment and historic-period archaeological resources (Potential Impacts 3.12-11 through 3.12-16) and tribal cultural resources (Potential Impacts 3.12-1 through 3.12-8) would be the same as those described for the Proposed Project and would be significant and unavoidable. However, under the Two Dam Removal Alternative, the Copco No. 2 facility, which contributes to the Klamath Hydroelectric Historic District [214], would not be removed and direct impacts to the historical significance of its structures and hydroelectric facilities (e.g., wooden-stave penstock) would not occur (Potential Impact 3.12-11). Installation of upstream and downstream fish passage at Copco No. 2 dam, including all associated construction activities, may impact Copco No. 2 Dam and its associated facilities, and combined with the removal of Copco No. 1 and Iron Gate facilities, the Two Dam Alternative could possibly affect the overall integrity of the Klamath Hydroelectric Historic District. This would be a significant

[214] The Klamath Hydroelectric Historic District is presumed eligible for inclusion on the National Register and the California Register due to its role in early development of electricity and economy of the southern Oregon and northern California regions (see also Section 3.12.2.3 *Known Tribal and Historical Resources in the Vicinity of the Proposed Project*).

and unavoidable impact for the reasons described under the Proposed Project (Potential Impact 3.12-11).

Leaving Copco No. 2 Dam in place under the Two Dam Removal would reduce impacts to known, or as yet unknown, tribal cultural resources located within the footprint of Copco No. 2 reservoir and its associated hydroelectric facilities. However, installation of upstream and downstream fish passage at Copco No. 2 dam and a new day use area near Copco No. 2 Dam, including all associated construction activities, may impact known, or as yet unknown, tribal cultural resources to a similar degree as that described for the Proposed Project. For this reason, and because Copco No. 1 and Iron Gate dams would be removed under this alternative as described for the Proposed Project, potential impacts to tribal cultural resources (Potential Impacts 3.12-1 through 3.12-8) would be the same as those described for the Proposed Project. Implementation of Mitigation Measures TCR-1 through TCR-8 would reduce impacts to tribal cultural resources, but for the reasons described under the Proposed Project, the impacts would remain significant and unavoidable.

There would be approximately 18.2 miles of additional riverine habitat that would become available for salmonids under this alternative (not including 3.5 miles of riverine habitat that would remain inundated by J.C. Boyle Reservoir, and an estimated 0.3 miles of riverine habitat that would remain inundated by Copco No. 2). The additional habitat, combined with a reduced incidence of fish disease and parasites in the Klamath River under this alternative (see Section 4.5.3.4 *Fish Disease and Parasites*), would improve conditions for the Klamath Cultural Riverscape related to fisheries (Potential Impact 3.12-9) relative to existing conditions. This would be a beneficial effect. Reductions in blue-green algae concentrations under this alternative (see Section 4.5.2.6 *Chlorophyll-a and Algal Toxins*) would support Cultural Use of Klamath River waters without risk of adverse health effects, which would improve tribal members' access to the river above levels occurring under existing conditions (Potential Impact 3.12-10) and would be a beneficial effect.

4.5.13 Paleontologic Resources

For the reasons described under the Proposed Project (Section 3.13.5 *[Paleontologic Resources] Potential Impacts and Mitigation*), there could be instances of bank erosion and slope failures in the Middle Klamath River due to changes in river discharge should Copco No. 1 and Iron Date dams be removed (Potential Impact 3.13-1). However, the magnitude of this bank erosion would not be substantial compared to the existing condition and there would be a low likelihood that downcutting or erosion of the Hornbrook Formation located downstream of Iron Gate Dam would occur to a greater degree than existing conditions. Because of their small size (2,267 acre-feet total storage for J.C. Boyle and 70 acre-feet total storage for Copco No. 2; see Table 3.6-4) and because they are not operated by PacifiCorp as a flood control reservoir, retaining J.C. Boyle and Copco No. 2 reservoirs under this alternative would not affect the likelihood of downcutting or erosion relative to existing conditions or the Proposed Project, and given the formation's Low Paleontologic Potential (Potential Impact 3.13-1), there would be no significant impact to paleontologic resources under the Two Dam Removal Alternative.

4.5.14 Land Use and Planning

Under the Two Dam Removal Alternative, the short-term impacts on land use and planning in California would be the same as those described for the Proposed Project in Section 3.14.5 *[Land use and Planning] Potential Impacts and Mitigation*, with the exception of the transfer of Parcel B lands. Because long-term land use under this alternative is currently unknown, this alternative does not assess the potential impacts of long-term use of the lands currently submerged under Iron Gate and Copco No. 1 reservoirs as that would require speculation. The dam removal actions at Copco No. 1 and Iron Gate dams would occur in the same manner under both the Two Dam Removal Alternative and the Proposed Project. Maintaining J.C. Boyle Dam 20 miles upstream in Oregon would not have an impact on California land use or planning. Additionally, the relatively small footprint of the Copco No. 2 Dam and associated facilities would not have a significant impact on land use and planning compared to the Proposed Project.

4.5.15 Agriculture and Forestry Resources

For the reasons discussed below, the potential for impacts on agriculture and forestry resources in California under the Two Dam Removal Alternative would be the same as that for the Proposed Project. Retaining J.C. Boyle Dam would not change or result in the conversion of any California land use relating to agriculture or forestry. In addition, the issues relating to agricultural water in the Lower Klamath Project area would be the same regardless of whether J.C. Boyle Dam remains in place or is removed. The relatively small footprint of the Copco No. 2 Dam and associated facilities does not affect agriculture and forestry resources, such that leaving this reservoir in place would not affect agriculture and forestry resources compared to the Proposed Project. Therefore, under the Two Dam Removal Alternative, potential impacts on agriculture and forestry resources would be the same as those of the Proposed Project and there would be no significant impacts (Potential Impacts 3.15-1 through 3.15-3).

4.5.16 Population and Housing

In California, although short-term dam deconstruction activities would not occur at Copco No. 2 Dam under the Two Dam Removal Alternative, construction of upstream and downstream fish passage facilities and a new day use area near Copco No. 2 Dam would occur and thus the level of overall construction activities and associated population and housing impacts would be slightly less than those described under the Proposed Project (Potential Impacts 3.16-1 and 3.16-2). If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle and Copco No. 2 dams would be further reduced relative to the Proposed Project. For reasons described for the Proposed Project, the Two Dam Removal Alternative would not result in a substantial influx of population (Potential Impact 3.16-1), nor would there be a need to displace existing residents or build replacement housing elsewhere (Potential Impact 3.16-2), and there would be no significant population and housing impacts.

4.5.17 Public Services

In California, although short-term dam deconstruction activities would not occur at Copco No. 2 Dam under the Two Dam Removal Alternative, construction of upstream and downstream fish passage facilities and a new day use area near Copco No. 2 Dam would occur and thus the level of overall construction activities and associated impacts to utilities and service systems would be slightly less than those analyzed under the Proposed Project. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle and Copco No. 2 dams would be further reduced relative to the Proposed Project. For reasons described for the Proposed Project, removal of the two largest California dams under this alternative would still result in significant impacts due to short-term increased response times for emergency fire, police, and medical services (Potential Impact 3.17-1). Mitigation Measure HZ-1 would reduce impacts. In addition, the KRRC is developing a Traffic Management Plan to identify mitigation and other protective measures that would be implemented to reduce impacts to public services. It would also be appropriate for the final Traffic Management Plan to include Recommended Measure TR-1. Overseeing development and implementation of the Traffic Management Plan does not fall within the scope of the State Water Board's water quality certification authority. While the State Water Board expects that this plan will be finalized and implemented, at this time the plan is not finalized, and the State Water Board cannot require its implementation. Accordingly, while the State Water Board anticipates that implementation of Mitigation Measure HZ-1 would reduce impacts to public services, because it cannot require implementation of Recommended Measure TR-1, it is analyzing the impacts under this alternative as significant and unavoidable.

With respect to the elimination of a long-term water source for wildfire services (Potential Impact 3.17-2), under this alternative J.C. Boyle Reservoir and Copco No. 2 Reservoir would remain in place and would serve as relatively accessible sources of water for helicopter fire suppression crews compared to the mainstem Klamath River. However, because J.C. Boyle Reservoir is approximately 20 river miles upstream of Copco No. 1 Reservoir and has a relatively small surface area (approximately 350 acres versus 942 acres [Iron Gate Reservoir] and 972 acres [Copco No. 1 Reservoir], see also Table 2.3-1), response and travel times between water fills related to this reservoir would still be increased over existing conditions. Within the California portion of the Hydroelectric Reach, Copco No. 2 Reservoir would remain as a local source of water for fire suppression relative to existing conditions. Copco No. 2 Reservoir has not been identified by CalFire as a water source for wildfire suppression during the past three years (2015−2018), although this may be because the much larger Copco No. 1 and Iron Gate reservoirs are directly adjacent and presently serve as adequate sources. Under the Two Dam Removal Alternative, Copco No. 2 Reservoir would provide a small surface area, potentially less than 10 acres depending on its upstream extent once Copco No. 1 Dam is removed. The considerably smaller surface area means that Copco No. 2 Reservoir could accommodate fewer helicopters at one time as compared with Copco No. 1 and Iron Gate reservoirs under existing conditions, which would increase response times. The State Water Board anticipates that implementation of alternative water sources for both ground and helicopter crews that are developed through the FERC process would provide a level of protection for reducing the public's risk of loss from wildfires, thereby reducing impacts to less than significant. The KRRC is developing a Fire Management Plan to identify mitigation and other protective measures that would be implemented to reduce impacts to public services. It would be appropriate for the final Fire Management Plan to include Recommended Measure PS-1. Overseeing development and implementation of the final Fire Management Plan does not fall within the scope of the State Water Board's water quality certification authority. While the State Water Board expects that this plan will be finalized and implemented, at this time the plan is not finalized, and the State Water Board cannot require its implementation. Accordingly, while the State Water Board anticipates that implementation of Recommended Measure PS-1 would reduce impacts to public services, because it cannot require implementation of Recommended Measure PS-1, it is analyzing the impacts under this alternative as significant and unavoidable.

Because removal of Copco No.1, Copco No. 2, and Iron Gate dams and associated facilities would occur under the Two Dam Removal Alternative in the same manner and to the same extent as under the Proposed Project, potential impacts on school services and facilities (Potential Impact 3.17-3) under this alternative would be the same as described for the Proposed Project and would be less than significant.

4.5.18 Utilities and Service Systems

Construction-related activity in California under the Two Dam Removal Alternative would require the need for onsite wastewater disposal, stormwater drainage, and/or solid waste disposal facilities at levels similar to that described for the Proposed Project (Potential Impacts 3.18-1 through 3.18-4) and would result in no significant impacts. Although short-term dam deconstruction activities would not occur at Copco No. 2 Dam and the need for offsite transport and disposal of the waste materials and quantities listed in Table 2.7-5 would be eliminated, there is sufficient permitted capacity to accommodate the solid waste disposal needs of the Lower Klamath Project regardless of whether the Copco No. 2 Dam and associated facilities are removed (Potential Impact 3.18-4). Under this alternative, construction of upstream and downstream fish passage facilities and a new day use area near Copco No. 2 Dam would be likely to require additional materials import, depending on the type of fish passage facilities and day use area that are constructed. However, the overall level of construction-related activity in California would be only slightly less than that described under the Proposed Project, regardless of the type of fishway used, such that the degree of difference would not be sufficient to significantly change the assessment of dam removal activities on the potential for impacts to utilities and service systems. There would be no significant impacts on utilities and service systems related to this degree of construction for the Two Dam Removal Alternative, and construction is the only part of the proposed activities that merits analysis for potential impacts on utilities and service systems.

4.5.19 Aesthetics

For the reasons described in Section 3.19.5 *[Aesthetics] Potential Impacts and Mitigation*, under the Two Dam Removal Alternative, short-term and long-term impacts on aesthetic resources in California, including a loss of open water and lake vistas in favor of more natural river, canyon, and valley vistas (Potential Impact 3.19-1) and changes in river flows, channel morphology, and visual water quality (Potential Impacts 3.19-2 and 3.19-3) would be the same as those of the Proposed Project, since the two largest Lower Klamath Project reservoirs (Copco No. 1 and Iron Gate) would be removed. Although Copco No. 2 Reservoir would not be removed, its small size (70 acre-feet) and lack of access does not provide a substantial open water vista under existing conditions and thus leaving it in place would not materially affect the value of scenic vistas as described under the Proposed Project (Potential Impact 3.19-1) and there would be no significant impacts. In addition, for the reasons described under the Proposed Project, visual changes resulting from drawdown of Copco No. 1 and Iron Gate reservoirs would still be significant and unavoidable in the short term and would have no significant impact in the long term (Potential Impact 3.19-4) under the Two Dam Removal Alternative.

Under the Two Dam Removal Alternative, the Copco No. 2 facilities would not be removed and installation of new upstream and downstream fish passage at Copco No. 2 Dam, including all associated construction activities, would occur. However, due to the small size of the Copco No. 2 facilities, their inaccessibility to the public, and the fact that they are already inconsistent with the area VRM classification, this would not change the significance determination.

Visual changes due to removal of Copco No. 1 and Iron Gate dams and facilities (Potential Impact 3.19-5), construction activities (Potential Impact 3.19-6) including fishway construction at Copco No. 2 Dam, would be the same as those of the Proposed Project since the manner of dam deconstruction for these two relatively large facilities would be the same under the Two Dam Removal Alternative; impacts would be less than significant. Similarly, impacts to nighttime views from construction lighting would be significant and unavoidable as under the Proposed Project (Potential Impact 3.19-7).

4.5.20 Recreation

Under the Two Dam Removal Alternative, short-term dam deconstruction activities would not occur at Copco No. 2 Dam, and construction of upstream and downstream fish passage facilities and a new day use area near Copco No. 2 Dam would occur, such that the level of overall construction activities and short-term impacts to recreational opportunities in California would be slightly less than those described under the Proposed Project (Potential Impact 3.20-1). For the reasons described in Potential Impact 3.20-1, there would be no significant impact on recreation from implementation of the Two Dam Removal Alternative.

Recreational facilities associated with Copco No. 1 and Iron Gate reservoirs would still be subject to closure and reservoir-related recreation use would still transfer to other regional recreational facilities and/or would be replaced with river-related recreation under this alternative. All portions of the existing recreational facilities at J.C. Boyle Reservoir (Pioneer Park, Topsy Campground, Spring Island River Access) would remain in place under this alternative, offering more regional boating and fishing recreational opportunities relative to the Proposed Project. Elimination of peaking operations under this alternative may increase the appeal of J.C. Boyle Reservoir recreational sites due to elimination of regular reservoir water level fluctuations, but otherwise there would be no change from existing conditions for J.C. Boyle Reservoir recreational opportunities. Although Copco No. 2 Reservoir would not be removed, its small size (70 acre-feet) does not support reservoir-based recreation under existing conditions and thus leaving it in place would not affect reservoir-based recreation opportunities compared to existing conditions and there would be no significant impacts (Potential Impacts 3.20-2 and 3.20-3).

Because long-term land use under this alternative is currently unknown, this alternative does not assess the potential impacts of long-term use of the lands currently submerged under Iron Gate and Copco No. 1 reservoirs as that would require speculation. Therefore, any adverse effects from the construction of new or expansion of existing recreational facilities (Potential Impact 3.20-4) is unknown and not analyzed for this alternative.

While the Two Dam Removal Alternative would not remove J.C. Boyle Reservoir, it also would increase minimum flows in the Bypass Reach, and would not include peaking power generation or release of flows for recreation at J.C. Boyle Dam. Since there would be no recreational flows in the Hydroelectric Reach under this alternative, and flows in the Hydroelectric Reach would be similar to those under the Proposed Project, the loss of whitewater boating opportunities in the Hell's Corner Reach (within the upper portion of the Hydroelectric Reach) would be the same as the Proposed Project (Potential Impact 3.20-5) and would be significant and unavoidable. Farther downstream in the Hydroelectric Reach, Copco No. 2 Dam would remain in place under this alternative, and a new day use area would be constructed near Copco No. 2 Dam that would serve as a whitewater boater take-out point for boaters putting in downstream of J.C. Boyle Dam (FERC 2007). Thus, the Two Dam Removal Alternative would not adversely impact potential new whitewater boating opportunities in the Copco No. 1 and Iron Gate reservoir footprints described for the Proposed Project.

Just downstream of Copco No. 2 Dam in the Copco No. 2 Bypass Reach, effects of the Two Dam Removal Alternative would be different than those described for the Proposed Project. Model results analyzed for the Proposed Project (Potential Impact 3.20-5) indicate that there would be a substantial increase in whitewater boating opportunities during the July through September time period under the 2013 BiOp Flows, which would be a long-term beneficial effect under the Proposed Project. Under the Two Dam Removal Alternative, water diversions for hydropower generation at Copco No. 2 Dam would continue to affect flows in the a 1.5-mile-long Bypass Reach in the Klamath River between the Copco No. 2 Dam and the Copco No. 2 Powerhouse (Figure 2.3-3), such that the long-term benefit to whitewater boating opportunities that would occur under the Proposed Project would not occur under this alternative. Relative to existing conditions, there would be a significant and unavoidable impact to whitewater boating opportunities in the Hell's Corner reach (within the upper portion of the Hydroelectric Reach), a less than significant impact in the Hydroelectric Reach in the Copco No. 1 and Iron Gate reservoir footprints, and no impact in the Copco No. 2 Bypass Reach (where conditions currently do not support whitewater boating), under the Two Dam Removal Alternative. For the reasons described for the Proposed Project (Potential Impact 3.20-5), there would be no significant impact to whitewater boating opportunities in the Middle and Lower Klamath River under this alternative.

Under the Two Dam Removal Alternative, removal of Copco No. 1 and Iron Gate dams and construction of upstream and downstream fish passage at Copco No. 2 and J.C. Boyle dams would beneficially affect recreational fishing of anadromous fish (Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout) throughout the Hydroelectric Reach in California, as described for the Proposed Project (Potential Impact 3.20-6). The primary difference under the Two Dam Removal Alternative is that approximately 3.5 miles of aquatic habitat within J.C. Boyle Reservoir and 0.3 miles of aquatic habitat within Copco No. 2 Reservoir would remain lentic rather than reverting to the riverine conditions described for the Proposed Project. However, the combined inundation length for Copco No. 2 and J.C. Boyle reservoirs is a small proportion (approximately 16 percent) of the 22 miles of Lower Klamath Project reservoir habitat that would be restored to riverine habitat under the Proposed Project (see also Section 4.5.3.7 *[Two Dam Removal Alternative] Aquatic Habitat*) and so the effect of the Two Dam Removal Alternative on California recreational fishing would remain beneficial compared with existing conditions.

The Two Dam Removal Alternative would result in the same impacts to other (non-whitewater boating) river-based recreational facilities in the Middle Klamath River and Lower Klamath River as the Proposed Project (Potential Impact 3.20-6). Water quality improvements would be beneficial for the Hydroelectric Reach, the Middle Klamath River downstream of Humbug Creek (RM 174.3), and the Lower Klamath River. With respect to potential flooding impacts to existing river-based recreational facilities, maintaining J.C. Boyle Reservoir and Copco No. 2 Reservoir would not affect flood hydrology, relative to Proposed Project or to existing conditions, in the Hydroelectric Reach or farther downstream Middle Klamath River and Lower Klamath River (see also Section 4.6.6 *Flood Hydrology*). As under the Proposed Project, there would be little to no change to the 100-year floodplain extent in the Klamath River and Lower Klamath River, with the exception of the reach along the Middle Klamath River from Iron Gate Dam (RM 193.1) to the confluence with Humbug Creek (RM 174.0), where the 100-year floodplain extent would change slightly due to removal of the California Lower Klamath Project dams. However, the slightly increased potential for flooding in this reach would not represent a change or loss of a rare or unique river-based recreational facility affecting a large area or substantial number of people and therefore impacts to recreation under the Two Dam Removal Alternative would be the same as those described for the Proposed Project (Potential Impact 3.20-6) and would be less than significant.

As under the Proposed Project, there would be long-term beneficial effects on the scenic quality, recreation, fisheries and wildlife of the California Klamath River wild and scenic river segment and to the resource values of the eligible and suitable wild and scenic river segment (Potential Impact 3.20-7), though some of the impacts (such as to scenic resources) would be less beneficial under the Two Dam Removal Alternative. However, beneficial effects on water quality, natural flow regimes and anadromous fisheries would still occur.

4.5.21 Hazards and Hazardous Materials

The Two Dam Removal Alternative would have similar potential impacts on hazards and hazardous materials as those described for the Proposed Project (see Section 3.22.5 *[Hazards and Hazardous Materials] Potential Impacts and Mitigation*). Short-term dam deconstruction activities would not occur at Copco No. 2 Dam under the Two Dam Removal Alternative, eliminating the need for offsite transport and disposal of potentially hazardous materials at Copco No. 2 Dam and Powerhouse, including the creosote-treated wooden-stave (redwood) penstock, coatings containing heavy metals in the powerhouse, on the exterior surfaces of the steel penstocks, air vents, and other painted materials, a fueling facility containing above-ground gasoline (1,000 gallon) and diesel (500 gallon) tanks, and underground septic systems used for seven residences near the powerhouse (see also Section 2.7.1.3 *Copco No. 2 Dam and Powerhouse).* While this alternative would reduce potential impacts in California due to reduced offsite transport and disposal of these hazardous materials relative to the Proposed Project, the aforementioned Copco No. 2 features that have coatings containing heavy metals, gasoline and diesel tanks, and underground septic systems could be damaged or exposed during or following construction activities and would require preservation to reduce the risk of environmental contamination. Further, construction of upstream and downstream fish passage facilities at Copco No. 2 Dam would result in an overall level of construction-related activity in California that would be only slightly less than that described under the Proposed Project, where the degree of difference would not be sufficient to significantly change the assessment of dam removal activities on the potential for hazard-related impacts due to transport or use of hazardous materials during construction activities as compared with those discussed under the Proposed Project. Lastly, maintaining J.C. Boyle Dam in Oregon would not change the hazards and hazardous materials analysis for California because the transport, use, and disposal of general construction waste materials (e.g., concrete, rebar, building waste, power lines) associated with J.C. Boyle Dam removal, as well as construction-related activities that could result in the accidental release of hazardous materials to the environment, would occur in Oregon. Overall, potential construction-related impacts under the Two Dam Removal Alternative would be slightly less than or the same as those of the Proposed Project (Potential Impacts 3.21-1, 3.21-2, and 3.21-4) and would be significant. Implementation of Mitigation Measure HZ-1 would be required to result in no significant impacts. For the reasons described for the Proposed Project, the potential short-term impact of this alternative on the implementation of adopted emergency response plans would be significant and unavoidable (Potential Impact 3.21-7).

With respect to removal of the Lower Klamath Project reservoirs as a readily available source of water for helicopter fire suppression crews fighting local fires, Copco No. 2 Reservoir has not been identified by CalFire as a water source for wildfires during the past three years (2015−2018), while Copco No. 1 and Iron Gate reservoirs have served in this capacity (see also Potential Impact 3.21-8). The two largest Lower Klamath Project reservoirs (Copco No. 1 and Iron Gate) would still be removed under this alternative, which would substantially increase the public's risk of loss, injury or death associated with wildfires as described for the Proposed Project (Potential Impact 3.21-8). J.C. Boyle Reservoir and Copco No. 2 Reservoir would remain in place and would continue to serve as accessible water surfaces for helicopter fire suppression crews compared to the mainstem Klamath River. However, because J.C. Boyle Reservoir is approximately 20 river miles upstream of Copco No. 1 Reservoir and has a relatively small surface area (approximately 350 acres versus 942 acres [Iron Gate Reservoir] and 972 acres [Copco No. 1 Reservoir], see also Table 2.3-1), response and travel times between water fills would still be increased over existing conditions and the Proposed Project for helicopter crews to fly to J.C. Boyle Reservoir for water pick up. Within the California portion of the Hydroelectric Reach, Copco No. 2 Reservoir would remain as a local source of water for fire suppression relative to existing conditions. However, this reservoir would have an even smaller surface area, potentially less than 10 acres (depending on its upstream extent) once Copco No. 1 Dam is removed. A smaller surface area means that it could theoretically accommodate fewer helicopters at one time, as compared with Copco No. 1 and Iron Gate reservoirs under existing conditions, which would increase response times. Overall, relative to existing conditions, removal of the two largest reservoirs (Copco No. 1 and Iron Gate) under the Two Dam Removal Alternative would result in a substantial increased public risk of loss, injury, or death involving wildland fires due to increased response and travel times relative to existing conditions and would be a significant impact.

4.5.22 Transportation and Traffic

For the reasons described in Section 3.22.5 *[Transportation and Traffic] Potential Impacts and Mitigation Measures*, removal of the two largest of the Lower Klamath Project dams and associated facilities (Copco No. 1 and Iron Gate) would still occur under the Two Dam Removal Alternative and would result in short-term potential impacts on transportation and traffic. In California, short-term dam deconstruction activities would not occur at Copco No. 2 Dam under this alternative, reducing the need for offsite waste transport and the number of associated truck trips relative to the Proposed Project. However, construction of upstream and downstream fish passage facilities at Copco No. 2 Dam would occur, potentially increasing the need for material import and associated California truck trips for this facility such that overall construction levels under this alternative would be slightly less than those described for the Proposed Project. In Oregon, construction of upstream and downstream fish passage at J.C. Boyle Dam would generate a short-term increase in construction-related vehicle trips, which would be similar to, albeit likely somewhat less than, transportation and traffic impacts described for dam deconstruction under the Proposed Project. Note that J.C. Boyle Dam-associated vehicle trips are included in the analysis of the Proposed Project as some of the construction-related traffic flow may use roads in California (e.g., I-5 to OR 66) and this also would be likely to occur under the Two Dam Removal Alternative.

As described in Section 3.22.5 *[Transportation and Traffic] Potential Impacts and Mitigation*, the Proposed Project would result in significant and unavoidable short-term impacts to traffic flow, road safety, road conditions, emergency access, public transit, and non-motorized transportation, unless and until KRRC reaches enforceable ‘good citizen’ agreements that are finalized and implemented through the FERC process and that include proposed items for the final Traffic Management Plan and Emergency Response Plan (Appendix B: *Definite Plan − Appendices O1 through O4*), as well as the additional components included in Recommended Measure TR-1 (Potential Impacts 3.22-1 through 3.22-5). Because the level of overall construction activities and impacts to transportation and traffic in California would be only slightly less than those described under the Proposed Project, the Two Dam Removal would also result in significant and unavoidable short-term impacts to the aforementioned traffic- and transportation-related activities and would require similarly enforceable ‘good citizen’ agreements to reduce impacts to less than significant, as described for the Proposed Project.

As described for the Proposed Project, the Lower Klamath Project dams are not located within two miles of an airport nor would their removal result in a change in air traffic patterns that would result in a substantial safety risks, regardless of whether J.C. Boyle Dam and Copco No. 2 Dam remain place, and there would be no significant impact (Potential Impact 3.22-6).

As described previously, fish passage under the Two Dam Removal Alternative would either be provided by volitional fishways, or trap and haul, or some combination. Facility construction, and thus any related potential transportation and traffic impacts, for trap and haul would be less than that described for fish ladders. Long term trap and haul operations would consist of trapping adult upstream migrants downstream of Copco No. 2 Dam and releasing them in J.C. Boyle Reservoir as an ongoing activity. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Copco No. 2 Dam. Roads within the traffic and transportation Area of Analysis currently carry substantially fewer vehicles than the planning capacity (Table 3.22-2 and Section 3.22.2.1*Traffic Flow*), such that additional truck trips, assuming both upstream and downstream trap and haul operations, would not substantially change traffic conditions. Although the exact extent and timing of these ongoing hauling activities is not known, it is unlikely that more than ten truck trips per day would be necessary, including a conservative assumption of round trip (i.e., upstream and downstream) hauling for 30 to 40 miles each way between Copco No. 2 Dam and J.C. Boyle Reservoir. Therefore, trap and haul traffic would be a less than significant impact.

Significance
No significant impact

4.5.23 Noise

For the reasons described in Section 3.23.5 *[Noise] Potential Impacts and Mitigation Measures*, removal of Copco No. 1 and Iron Gate dams would result in noise and vibration that would affect sensitive receptors and exceed Siskiyou County General Plan standards under this alternative. The Two Dam Removal Alternative would have slightly less short-term potential impacts on noise than those described for the Proposed Project since short-term dam deconstruction activities would not occur at Copco No. 2 Dam. However, construction of upstream and downstream fish passage facilities would occur and would likely generate short-term increases in daytime and nighttime noise levels affecting nearby residents such that overall there would be significant and unavoidable adverse environmental impacts resulting from: construction equipment exceeding maximum allowable noise levels (Potential Impact 3.23-1); noise disturbance to residents from construction-generated noise at Copco No. 1 and Iron Gate dams (Potential Impacts 3.23-2 and 3.23-4), reservoir restoration at Copco No.1 and Iron Gate dams (Potential Impact 3.23-5); and vibration disturbance from blasting activities at Copco No. 1 and Iron Gate dams (Potential Impact 3.23-6). Other noise and vibration generation from the Two Dam Removal Alternative would not have a significant adverse impact (Section 3.23-5 *[Noise] Potential Impacts and Mitigation*).

As described previously, fish passage under the Two Dam Removal Alternative would either be provided by volitional fishways, or trap and haul, or some combination. If trap and haul were to be used there could be potential long-term noise-related impacts due to regular truck traffic during seasonal trap and haul operations, as described below.

Potential Impact 4.5-1 Trap and haul-related noise.
Activities associated with the implementation of seasonal trap and haul operation prescriptions for Copco No. 2 Dam and associated facilities could result in daytime and nighttime noise levels affecting nearby residents. Trap and haul operations for J.C. Boyle would occur in Oregon and thus would not result in noise-related impacts in California. As described under the analysis of traffic flow effects for the Continued Operations with Fish Passage Alternative (Section 4.4), vehicle trips associated with trap and haul operations would take place following dam deconstruction and fishway construction. There would be no overlap between these trips and peak construction-related traffic. The closest noise-sensitive receptor to Copco No. 2 Dam is the Janice Avenue rural residential area, located approximately 3,700 feet to the east of the dam (Figure 3.23-4). The line of sight from the receptor to Copco No. 2 Dam is blocked by a hill. Due to the natural topography surrounding the dam and the distance between the dam and the receptor, noise from ongoing, seasonal trap and haul activities at the Copco No. 2 Dam would be reduced to less than significant levels at sensitive receptors.

Significance
No significant impact

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4.6 Three Dam Removal Alternative

4.6.1 Introduction

4.6.1.1 Alternative Description

In the Three Dam Removal Alternative, the Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities would be fully removed, and J.C. Boyle dam and associated facilities would remain. The J.C. Boyle Dam facilities that would remain include (see also Figure 2.3-1):

1. A 2,629-acre-feet reservoir (J.C. Boyle Reservoir);
2. A 68-foot tall earthfill dam (J.C. Boyle Dam), concrete spillway, and three spill gates;
3. A concrete intake structure connecting to a 2.5-mile water conveyance system with an overflow forebay;
4. A 98-megawatt (MW) J.C. Boyle Powerhouse;
5. A switchyard with 2.8 miles of transmission lines; and
6. Ancillary buildings including an office building (known as the Red Barn), maintenance shop, fire protection building, communications building, two occupied residences, and a warehouse.

This alternative assumes that the J.C. Boyle Dam facilities would be relicensed by FERC for continued operations with changes to allow for upstream and downstream fish passage and updated flow requirements. More specifically, the Three Dam Removal Alternative assumes conditions described in the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*[215] for J.C. Boyle Dam. The primary conditions assumed for the Three Dam Removal Alternative are the following:

- *Fishway Prescriptions* – volitional year-round upstream and downstream fish passage at J.C. Boyle Dam consistent with the prescriptions from the DOI and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007) and upheld in a trial-type administrative hearing, and specific fishway facility design and construction details included in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*[215], including fishway (i.e., fish ladder and screens) installation for both upstream and downstream migrations and barriers to prevent entrainment into turbines; and
- *Changes to J.C. Boyle Operations* – At least 40 percent of J.C. Boyle Reservoir inflow to be released downstream through the J.C. Boyle Bypass to increase minimum flows in the Bypass Reach (RM 225.2 to RM 229.8). J.C. Boyle hydroelectric peaking operations and/or recreation flows would not occur under the Three Dam Removal Alternative since Copco No. 1 and Iron Gate dams would not be present to reregulate flows downstream. Power generation would be suspended and all inflow to J.C. Boyle Reservoir would be released down the Bypass Reach under the seasonal high flow event that would occur for seven full

[215] The KHSA 2012 EIS/EIR's *Section 2.4.5 Fish Passage at Four Dams Alternative* and *Section 2.4.6 Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative* (included in Appendix U of this EIR) include fishway facility design and construction details beyond what are specifically required in the FERC prescriptions and that are based on designs of similar fishway facilities used at other hydroelectric facilities.

days in later winter/spring when inflows to J.C. Boyle first exceed 3,300 cfs (DOI 2007; NMFS 2007; FERC 2007).

The following conditions under the Three Dam Removal Alternative are modifications to the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*:

- Removal of Copco No. 2 facilities as described under the Proposed Project; and
- Flows specified in the NMFS and USFWS 2013 BiOp for the USBR Klamath Irrigation Project, which are currently being considered under reinitiated consultation (see also 3.1.6.1 *Klamath River Flows under the Klamath Irrigation Project's 2013 BiOp*).

As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing and emergency dilution flows are required to be released from Iron Gate Dam as part of re-initiation of consultation on the 2013 BiOp Flows, but they are not modeled as part of existing conditions hydrology. Potential new BiOp flow requirements under this alternative are speculative at this time, and it is not clear whether flushing and emergency dilution flow requirements would continue under the new BiOp during or after dam removal. However, the 2017 flow requirements are considered to be the most reasonable assumption for conditions until agency formal consultation is completed and a new BiOp is issued. For analysis of potential impacts related to fish disease, the Three Dam Removal Alternative considers conditions with and without 2017 court-ordered flushing flows.

Additionally, this section addresses the potential effects of using fishways other than the volitional ladders described in the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, and points out where such other fishways would result in different effects than fish ladders. Such fishway installation could include trap and haul facilities or a combination of these two approaches. Regardless of how fish passage is provided, this alternative assumes fish passage consistent with the general prescriptions (DOI 2007) that cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007).

This alternative does not make any assumptions regarding conditions that could be imposed by the states of Oregon or California through water quality certification authority.

The aforementioned flow-related measures would reduce power generation at J.C. Boyle Dam. This alternative assumes that installation of fish passage facilities would follow the schedule described in *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*[216], which would install downstream passage facilities prior to

[216] Fishway feature design was provided in the 2012 KHSA EIS/EIR *Section 2.4.5 Fish Passage at Four Dams Alternative* and *Section 2.4.6 Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative* (Appendix U) and is used for this EIR to support the construction-related effects analysis. The KRRC would be required to obtain concurrence from USFWS and NMFS regarding fishway design and construction plans for each Lower Klamath Project facility prior to advancing to feasibility-level of design.

upstream passage facilities and would take place over a 4-month period (June through September of dam removal year 2) for J.C. Boyle Dam. The level of construction for fish passage at J.C. Boyle Dam would be consistent with that estimated for development of the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*[216], which includes removal of the existing J.C. Boyle fish ladder structure, construction of a new fishway at or near the same location as the existing fish ladder (Figure 2.3-1), and construction of downstream fish passage.

As neither the Fall Creek nor the Iron Gate hatchery facilities were built to address potential fisheries effects of J.C. Boyle Dam (Boyle 1976), this alternative assumes that hatchery operations would continue for eight years under the Three Dam Removal Alternative, with reduced production goals consistent with those described for the Proposed Project (see Section 2.7.6 *Hatchery Operations*).

Although leaving J.C. Boyle Dam in place, removing the existing fish ladder and installing a new fish ladder, would be less construction than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to resources in California since J.C. Boyle is located in Oregon. California materials import for Copco No. 1, Copco No. 2, and Iron Gate facilities deconstruction would be the same as that described in Section 2.7.1 *Dam and Powerhouse Deconstruction,* and California waste disposal quantities, truck trips, and haul distances would be the same as presented in Table 2.7-3 (Copco No. 1 Dam), Table 2.7-5 (Copco No. 2 Dam), and Table 2.7-7 (Iron Gate Dam). Further, this alternative assumes that construction activities to meet FERC prescriptions for fish passage would occur at the J.C. Boyle Dam concurrent with activities for removal of the other Lower Klamath Project dams and associated facilities, such that any construction-related impacts would also occur concurrently and some of these (e.g., water quality) could result in downstream impacts in California. As described previously, fish passage under the Three Dam Removal Alternative would be provided by volitional fishways, trap and haul, or some combination. Overall, regardless of the method of fish passage, the level of construction activities in the Hydroelectric Reach in California under the Three Dam Removal Alternative would not be materially different than that described for the Proposed Project. California workforce projections under the Three Dam Removal Alternative also would be the same as those presented for the Proposed Project (Table 2.7-18).

If instead of a fish ladder, trap and haul or some combination of fish passage methods were used, there would be the potential for reduced construction compared to the aforementioned activities for a fish ladder. While trap and haul facilities differ by site, common features include a trap holding pool, diffusers or gates to guide fish into the trap, a channel or port for discharge of attraction flows, a lift mechanism for truck-loading fish, a truck loading station, and a discharge platform. Much of the trap and haul facility would be located in-stream, with only the truck loading station and discharge platform potentially requiring upland grading or other earthwork.

Because long-term land use under this alternative is currently unknown, this alternative does not assess the potential impacts of long-term use of the lands currently submerged under Iron Gate and Copco No. 1 reservoirs as that would require speculation.

4.6.1.2 Alternative Analysis Approach

The potential impacts of the Three Dam Removal Alternative are analyzed in comparison to existing conditions, with reference to impact analyses conducted for the No Project Alternative or the Proposed Project, where appropriate. Unless otherwise indicated, the significance criteria, area of analysis, environmental setting, and impact analysis approach, including consideration of existing local policies, for all environmental resource areas under the Three Dam Removal Alternative are the same as those described for the Proposed Project (see Section 3.1 *Introduction* and individual resource area subsections in Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures*). The potential impacts and impacts for each environmental resource area are analyzed both in the short term and the long term, and unless otherwise indicated, use the same definitions of short term and long term as described for each resource area analyzed for the Proposed Project. Unless otherwise indicated, the mitigation measures described in Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures* are similarly applicable. This section describes changes to mitigation measures in light of differing project impacts associated with this alternative.

4.6.2 Water Quality

Water quality modeling results applicable to the Three Dam Removal Alternative are not as extensive as results applicable to the Proposed Project or the No Project Alternative. The effects of Three Dam Removal Alternative can be assessed through a combination of modeling scenarios undertaken for the Proposed Project and other alternatives. Appendix D of this EIR summarizes the models used to evaluate potential water quality impacts, including identification of which model scenarios are directly applicable to the Three Dam Removal Alternative. The Klamath River Water Quality Model (KRWQM) developed by PacifiCorp and the River Basin Model 10 (RBM10) developed as part of the Klamath Dam Removal Secretarial Determination studies both include modeling scenarios that have J.C. Boyle remaining in place and Copco No. 1, Copco No. 2, and Iron Gate dams removed. An evaluation of model results from different reaches within the Klamath River also can be used to assess how J.C. Boyle remaining in place would impact water quality. The Klamath TMDL model includes a “TMDL dams-in” scenario (T4BSRN), which approximates the condition where the Lower Klamath Project dams remain in place, as well as the TOD2RN (Oregon reaches) and TCD2RN (California reaches) scenarios (together the “TMDL dams-out” scenario) that assume the removal of the Lower Klamath Project (see Appendix D for more detail). The Klamath TMDL model assumes full TMDL implementation for both “TMDL dams-in” and “TMDL dams-out” scenarios. While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*). For example, comparisons of the modeling scenarios “TMDL dams-in” Oregon reaches (TOD2RN) and “TMDL dams-out” (T4BSRN) for the reach between J.C. Boyle Dam and the upstream end of Copco No. 1 Reservoir document how the presence of J.C. Boyle Dam influences conditions in that portion of the Hydroelectric Reach. Similarly, comparison of the SRH-1 sediment modeling results downstream of J.C. Boyle Dam with the SRH-1 results downstream of Iron Gate Dam, and SRH-2D sediment modeling results showing the suspended sediment concentrations from removal of only Copco No. 1 Dam, provides significant insight into the similarities and differences between suspended sediment concentrations due to the release of reservoir deposited sediments under the Three Dam Removal Alternative and under the Proposed Project. Overall, the available water quality modeling results provide sufficient information that the water quality impacts under the Three Dam Removal Alternative can be quantitatively or qualitatively assessed, as described below.

4.6.2.1 Water Temperature

In general, the Three Dam Removal Alternative would have the same or similar potential impacts on water temperature in California as those identified under the Proposed Project. The presence of the J.C. Boyle Reservoir on the Klamath River does not alter water temperatures in further downstream reaches because it has a shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days) that does not support thermal stratification (FERC 2007). However, J.C. Boyle Dam operations do influence Klamath River water temperatures by releasing flow for peaking power generation and whitewater recreation. These releases cause water temperature variations in the J.C. Boyle Bypass and Peaking reaches, including from the Oregon-California state line to Copco No. 1 Reservoir, due to diversion of warmer reservoir discharges around the J.C. Boyle Bypass Reach, cold groundwater spring flows into the J.C. Boyle Bypass Reach, and the mixing of these flows when they rejoin in the J.C. Boyle Peaking Reach of the Klamath River. The combination of these flows produce an observed increase in daily water temperature range above the natural diel (24-hour) water temperature fluctuations in the J.C. Boyle Peaking Reach at the Oregon-California state line.

The Three Dam Removal Alternative would not include peaking power generation or whitewater recreation flows from J.C. Boyle Dam since the downstream dams would not be available to reregulate the peaking and recreation flows. Elimination of the peaking and recreation flows from J.C. Boyle Dam would likely result in J.C. Boyle operating in a run of the river manner and increases in the water temperature range associated with J.C. Boyle operations would no longer occur under both the Three Dam Removal Alternative and the Proposed Project (see also Section 3.2.2.2 *Water Temperature*).

Model results analyzed for the Proposed Project do not explicitly isolate the effects of the four individual Lower Klamath Project reservoirs on water temperatures, but the KRWQM includes a scenario in which only Iron Gate and Copco No. 1 dams are removed[217] with J.C. Boyle and Copco No. 2 remaining in place ("WIGC" PacifiCorp 2004a; Dunsmoor and Huntington 2006; see also Appendix D of this EIR). KRWQM WIGC results indicate that compared with removal of J.C. Boyle, Copco No. 1 and Iron Gate reservoirs ("WIGCJCB"), the long-term effects of removing Iron Gate, Copco No. 1, and Copco No. 2 reservoirs and converting the reservoir areas to a free-flowing river under the Three Dam Removal Alternative would be similar to effects on water temperature under the Proposed Project as illustrated in Figure 4.6-1.

[217] Copco No. 2 dam was not explicitly included in the model due to its negligible size and hydraulic residence time.

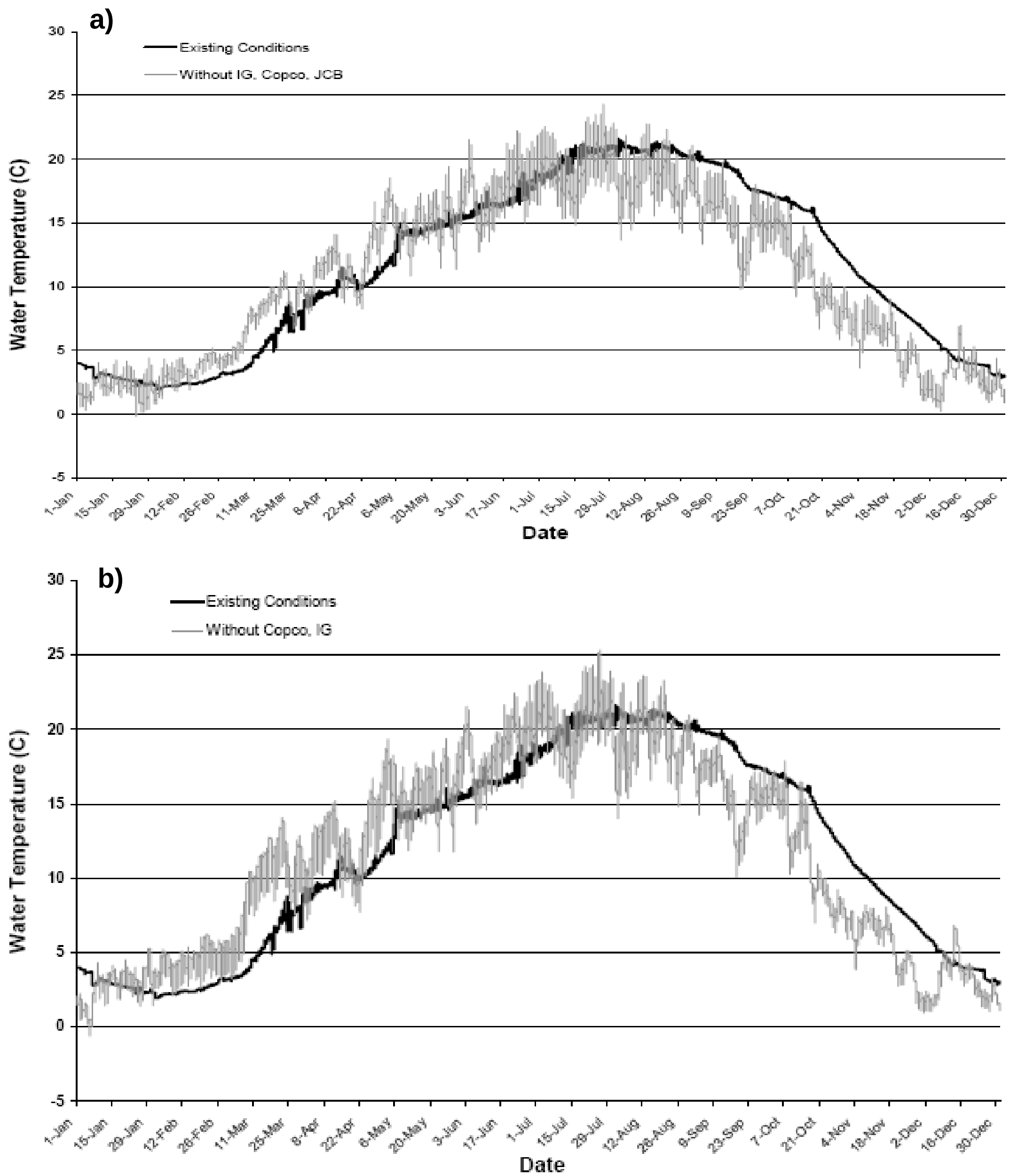

Figure 4.6-1. Simulated Hourly Water Temperature Downstream from Iron Gate Dam Based on Year 2004 for Current Conditions Compared to Hypothetical Conditions: (a) without Iron Gate (IG), Copco No. 1 and 2, and J.C. Boyle (JCB) Dams and (b) without Iron Gate (IG) and Copco No. 1 and 2 Dams. Source: PacifiCorp 2005.

Relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on water temperature would be the same as or similar to those described for the Proposed Project, except as follows:

- J.C. Boyle Reservoir would not alter water temperature in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir. J.C. Boyle Dam operations for peaking and recreation releases under existing conditions that cause increases in the water temperature range would be eliminated under both the Three Dam Removal Alternative and the Proposed Project. Short-term and long-term alterations in water temperatures in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir under the Three Dam Removal Alternative would result in water temperature effects similar to those of the Proposed Project (i.e., slightly lower maximum water temperatures and less artificial diel (24-hour) temperature variation during summer and early fall, see also Potential Impact 3.2-1) and would be beneficial.
- Short-term and long-term alterations in water temperatures due to conversion of the Copco No. 1 and Iron Gate reservoir areas to a free-flowing river (Potential Impact 3.2-1) would be the same as under the Proposed Project, and would be beneficial for the Hydroelectric Reach and the Middle Klamath River to the confluence with the Salmon River. As under the Proposed Project, there would be no significant impact for the Middle Klamath River downstream from the Salmon River, the Lower Klamath River, and the Klamath River Estuary.
- Sediment trapped by J.C. Boyle Dam would not be released under the Three Dam Removal Alternative, but the magnitude of the sediment releases from Copco No. 1 and Iron Gate reservoirs[219] would still be over 90 percent of the sediment releases under the Proposed Project (Table 2.7-11). Thus, the overall short-term and long-term alterations in seasonal water temperatures in the Klamath River Estuary due to potential morphological changes induced by sediment release from Copco No. 1 and Iron Gate reservoirs and subsequent deposition in the Klamath River Estuary would be similar under the Three Dam Removal Alternative and the Proposed Project (Potential Impact 3.2-2), and there would be no significant impact.

4.6.2.2 Suspended Sediments

As the Three Dam Removal Alternative does not include the removal of J.C. Boyle Dam, short-term mobilization of J.C. Boyle reservoir sediment deposits would not occur under this alternative and none of the associated 1,190,000 cubic yards of deposits estimated to occur in the reservoir in 2020[218] (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-10 and 2.7-11) would be eroded or delivered to downstream reaches and the Pacific Ocean. The approximately 27 to 51 percent of the sediment trapped behind the J.C. Boyle Dam predicted to move downstream through the California reaches of the Klamath River and out into the Pacific Ocean under the Proposed Project (USBR 2012) would not be transported under the Three Dam Removal Alternative.

[218] Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable.

However, Copco No. 1 and Iron Gate reservoirs contain approximately 92 percent of the total estimated 2020 reservoir deposits (50 and 42 percent, respectively) such that approximately 92 to 94 percent of sediment anticipated to erode from these reservoirs[219] under the Proposed Project (Table 2.7-10 and Table 2.7-11) would still occur under the Three Dam Removal Alternative. Increases in suspended sediment concentrations (SSCs) in the Hydroelectric Reach upstream of Copco No. 1 Reservoir from removal of J.C. Boyle Reservoir would be eliminated under this alternative since reservoir deposited sediment would not be released from J.C. Boyle Reservoir. While there would be some reduction in SSCs downstream of Copco No. 1 due to no SSCs being released by J.C. Boyle Dam removal, the reduction of SSCs under the Three Dam Removal Alternative would not alter the overall impact of dam removal on SSCs compared to the Proposed Project in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, or the nearshore marine environment. Modeling of SSCs downstream of Copco No. 1 Reservoir from release of only Copco No. 1 Reservoir sediment deposits across the wet, average, and dry water year types indicate SSCs, within the general uncertainty of the model, would peak at approximately 7,000 to 8,000 mg/L between Copco No. 1 Dam and Iron Gate Reservoir within one to two months of reservoir drawdown, then SSCs would decrease to generally less than 1,000 mg/L within approximately one more month (Figure 3.2-15; see Section 3.2.5.2 *Suspended Sediments*). Thus, SSCs in the Hydroelectric Reach between Copco No. 1 and Iron Gate reservoirs would still exceed the significance criteria for suspended sediment (SSCs greater than 100 mg/L over a continuous two-week exposure period) under the Three Dam Removal Alternative due to the overall magnitude of reservoir deposits still anticipated to erode from Copco No. 1 and Iron Gate reservoirs. Downstream of the Hydroelectric Reach, SSCs would also exceed the significance criteria for suspended sediment under the Three Dam Removal Alternative since over 90 percent of the reservoir deposited sediments anticipated to be transported under the Proposed Project would still occur. Thus, the overall short-term impact of increases in SSCs due release of sediments currently trapped behind Copco No. 1 and Iron Gate dams under the Three Dam Removal Alternative would be similar to impacts under the Proposed Project (see Section 3.2.5.2 *Suspended Sediments* for additional details).

Sediments and suspended materials (inorganic and organic) would continue to be intercepted and retained behind J.C. Boyle Dam in the long term under the Three Dam Removal Alternative since that dam would remain in place. While the amount of sediment supplied to the Klamath River on an annual basis from the watershed upstream of J.C. Boyle is a relatively small fraction of the total sediment (Stillwater Sciences 2010) (see also Section 3.11.2.4 *Sediment Load*), the long-term increase in mineral (inorganic) suspended material downstream of J.C. Boyle Dam under this alternative would be less than under the Proposed Project since J.C. Boyle Dam would continue to intercept upstream sediment. The majority of algal-derived (organic) suspended material from upstream sources (Upper Klamath Lake, Klamath Straights Drain, Lost River) is intercepted and retained by the Keno Impoundment/Lake Ewauna, but J.C. Boyle Dam does retain some algal-derived (organic) suspended material (see Appendix C, Section C.2.1 *Upper Klamath Basin* for more detail). Thus, the long-term

[219] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown of Copco No. 2 Dam begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

increases in algal-derived (organic) suspended material downstream of J.C. Boyle Dam under this alternative would be less than under the Proposed Project.

Long-term interception and retention of sediments and suspended materials (inorganic and organic) would not occur behind Copco No. 1, Copco No. 2[220], and Iron Gate dams since they would be removed under the Three Dam Removal Alternative. Long-term increases in mineral (inorganic) and algal-derived (organic) suspended material under this alternative would be less than under the Proposed Project because J.C. Boyle Dam would continue to retain sediments and suspended materials from upstream of that dam. However, the overall long-term impact from changes in the interception of sediments due to retention of J.C. Boyle Dam and removal of Copco No. 1, Copco No. 2, and Iron Gate dams would be similar under both the Three Dam Removal Alternative and the Proposed Project. The long-term increases in mineral (inorganic) and algal-derived (organic) suspended material due to the lack of interception by the dams would be a less than significant impact under the Proposed Project since only a small amount of sediment and suspended material is delivered from upstream of J.C. Boyle Dam. Thus, a decrease in the amount of sediment transported downstream under the Three Dam Alternative due to the retention of J.C. Boyle Dam and removal of Copco No. 1, Copco No. 2, and Iron Gate dams would still be a less than significant impact.

Relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on suspended sediments would be the same as or similar to those described for the Proposed Project, except as follows:

- As discussed in the first two paragraphs of this section, there would be no change in SSCs from the existing conditions in the Hydroelectric Reach between the Oregon-California state line and the upstream end of Copco No. 1 Reservoir since sediment deposits in J.C. Boyle Dam would remain in place. However, the increases in suspended sediment in the Hydroelectric Reach due to release of sediments currently trapped behind Copco No. 1 and Iron Gate Dams would remain a short-term significant and unavoidable impact for the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary (Potential Impact 3.2-3). The magnitude of suspended sediments increases in the Pacific Ocean nearshore environment due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams would be within the range of historical conditions, but the duration (i.e., weeks) of elevated suspended sediments still would be greater than historical conditions, thus there would be a short-term significant and unavoidable impact on suspended sediments in the Pacific Ocean nearshore environment (Potential Impact 3.2-3). Suspended sediments would resume modeled background levels by the end of Post-Dam removal year 1, so there would be no significant impact in the long term for the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment (Potential Impact 3.2-3). The short-term significant impact of increases SSCs due to dam removal in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment cannot be avoided or substantially decreased through reasonably feasible mitigation.

[220] Copco No. 2 Dam does not intercept or retain appreciable amounts of sediment (USBR 2011b).

- While there would not be potential construction-related short-term increases in suspended material from removal of J.C. Boyle Dam under the Three Dam Removal Alternative, there would be construction of new fish passage facilities at J.C. Boyle Dam that would potentially result short-term increases in suspended material downstream in California. Potential construction-related short-term increases in suspended material from pre-construction, dam removal, and restoration activities at Copco No. 1, Copco No. 2, and Iron Gate dams would be the same under the Three Dam Removal Alternative as under the Proposed Project since these activities would occur in both scenarios. Under the Three Dam Removal Alternative, short-term increases in suspended material from stormwater runoff due construction activities associated with new fish passage facilities at J.C. Boyle Dam and pre-construction, dam removal, and restoration activities at Copco No. 1, Copco No. 2, and Iron Gate dams would be potentially significant impacts without mitigation in the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam and in the Middle Klamath River immediately downstream of Iron Gate Dam (Potential Impact 3.2-4). Implementation of mitigation measures WQ-1, TER-1, and HZ-1 would reduce this potential impact under the Three Dam Removal Alternative to no significant impact, similar to the Proposed Project.
- As discussed earlier in this section, there would be no long-term change from existing conditions regarding the interception and retention of mineral (inorganic) (Potential Impact 3.2-5) or algal-derived (organic) (Potential Impact 3.2-6) suspended material by J.C. Boyle Dam in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir under the Three Dam Removal Alternative because J.C. Boyle Dam would remain in place and continue to intercept and retain mineral and algal-derived suspended material to the same extent that it currently does. However, similar to under the Proposed Project, there would be potential long-term increases in suspended material in the Hydroelectric Reach downstream of Copco No. 1 Reservoir because Copco No. 1, Copco No. 2, and Iron Gate dams would be removed under this alternative and they would no longer intercept and retain suspended material. While there would be no long-term change in the suspended material in the Hydroelectric Reach from the Oregon-California state line to Copco No. 1 Reservoir under the Three Dam Removal Alternative, the removal of Copco No. 1, Copco No. 2, and Iron Gate dams would result in this alternative having an overall similar long-term increase in suspended material due to lack of interception or retention by dams downstream of Copco No. 1 Dam as the Proposed Project. There would be no significant impact under the Three Dam Removal Alternative from long-term increases in suspended material due to the lack of continued interception and retention of mineral (inorganic) and algal-derived (organic) for the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam, the Middle Klamath River, Lower Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environment, similar to under the Proposed Project (Potential Impact 3.2-5 and 3.2-6).

4.6.2.3 Nutrients

Short-term or long-term increases in sediment-associated nutrients due to release of J.C. Boyle reservoir sediment deposits would not occur in the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir under the Three Dam Removal Alternative because none of the associated 1,190,000 cubic yards of deposits estimated to occur in the reservoir in 2020[221] (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches. As detailed in Section 4.6.2.2 *Suspended Sediments*, approximately 27 to 51 percent of the sediment trapped behind the J.C. Boyle Dam is predicted to be transported under the Proposed Project (USBR 2012), but this would not occur under the Three Dam Removal Alternative. Thus, nutrients associated with these sediments also would not be transported downstream and there would be no increase in sediment-associated nutrients from existing conditions in the Hydroelectric Reach between the Oregon-California state line and the upstream end of Copco No. 1 Reservoir associated with the Three Dam Removal Alternative.

However, approximately 92 to 94 percent of the sediment anticipated to erode from Copco No. 1 and Iron Gate reservoirs[222] under the Proposed Project (Table 2.7-11) would occur under the Three Dam Removal Alternative and mobilization of nutrients associated with these reservoir sediment deposits would occur. The majority of sediment-associated nutrients would be transported under both this alternative and the Proposed Project, but sediment-associated nutrients downstream of Copco No. 1 Dam would be slightly less under the Three Dam Removal Alternative than under the Proposed Project because nutrients associated with J.C. Boyle reservoir sediments would not contribute to nutrient concentrations. Thus, overall pattern and duration of short-term and long-term increases in sediment-associated nutrients due to release of sediments from behind the Copco No. 1 and Iron Gate dams under the Three Dam Removal Alternative would be similar to the Proposed Project in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, or the nearshore marine environment, but the magnitude of nutrient concentrations would be slightly less. See Section 3.2.5.3 *Nutrients* for further details.

Since J.C. Boyle dam would remain in place, continuing interception and retention of sediment-associated nutrients and suspended materials would still occur behind J.C. Boyle Dam in the long term. However, TMDL modeling[223] and empirical data indicate that J.C. Boyle Dam does not retain high amounts of nutrients such that long-term effects of dam removal on nutrient levels in the Hydroelectric Reach under the Proposed Project would be primarily due to the removal of Copco No. 1 and Iron Gate dams (see also Section 3.2.2.4 *Nutrients* and Section 3.2.5.3 *Nutrients* for information on the existing conditions for nutrients in the reservoirs). More specifically, the "TMDL dams-in"

[221] Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable.

[222] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown of Copco No. 2 Dam begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

[223] While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*).

Oregon reaches (TOD2RN) scenario indicates that Copco No. 1 retains approximately 10.0 percent of the annual total nitrogen and approximately 5.1 percent of the annual total phosphorus; and Iron Gate retains approximately 6.7 percent of the annual total nitrogen and approximately 3.3 percent of the annual total phosphorus (North Coast Regional Board 2010). The relative amounts of nutrient retention in each of the reservoirs without full TMDL implementation may be somewhat higher than the aforementioned estimates because the model mechanism increases the rate of retention as incoming nutrient concentrations increase; however, the model mechanism also indicates that the longer the retention time of water in the reservoir, the higher the nutrient retention. Copco No. 1 and Iron Gate reservoirs have average retention times of 11 days and 15 days, respectively, while J.C. Boyle Reservoir has a lower retention time of only approximately 1 day (Table 3.6-4) and thus allows most sediment-associated nutrients to pass through the reservoir and move downstream. Overall, under the Three Dam Removal Alternative, long-term interception and retention of sediments and suspended materials behind Copco No. 1 and Iron Gate dams would cease, since the facilities would be removed, and nutrient removal for the Hydroelectric Reach would be similar to that described for the Proposed Project.

Relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on nutrients would be the same as or similar to those described for the Proposed Project, except as follows:

- There would be no short-term or long-term change to the existing condition with regard to sediment-associated nutrients in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir, since sediment deposits in J.C. Boyle Dam would remain in place and no sediment-associated nutrients would be transported due to the release of sediments trapped behind J.C. Boyle Dam. However, there would be short-term increases in sediment-associated nutrients due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams[224] as in the Proposed Project (Potential Impact 3.2-7). Potential short-term increases in suspended material from construction of a new fish ladder at J.C. Boyle would be not result in short-term increases in sediment-associated nutrients since potential construction sediments would only have the nutrient content of the soils surrounding J.C. Boyle with substantially less nutrients than reservoir sediment deposits. As described in Section 3.2.5.3 Nutrients, this would result in no significant impact in the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam, the Middle Klamath River, the Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment
- Under the Three Dam Removal Alternative, there would be no long-term change from existing nutrient levels due to interception of nutrients by J.C. Boyle Dam in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir since J.C. Boyle Dam would remain in place. However, Copco No. 1, Copco No. 2, and Iron Gate dams would be removed and replaced by a free-flowing river under this alternative, so these dams would no longer intercept and retain incoming nutrients. As under the Proposed Project, long-term increases in nutrient levels from the lack of continued interception by the

[224] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown of Copco No. 2 Dam begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

Copco No. 1, Copco No. 2, and Iron Gate dams and conversion of the reservoir areas to a free-flowing river (Potential Impact 3.2-8) would result in no significant impact for the Hydroelectric Reach, Middle and Lower Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environment.

4.6.2.4 Dissolved Oxygen

J.C. Boyle Reservoir sediment deposits (approximately 1,190,000 cubic yards in 2020[225] or approximately eight percent of total sediment volume trapped behind the Lower Klamath Project dams, see also Tables 2.7-7 and 2.7-8) would be not mobilized in the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir under the Three Dam Removal Alternative since J.C. Boyle Dam would remain in place (see Section 4.6.2.2 *Suspended Sediments*). Thus, the short-term mobilization associated effects of these sediments on sediment-associated oxygen demand and dissolved oxygen (i.e., high content of organic carbon present in the reservoir sediments allows for the possibility of microbial oxidation of organic matter exposed to the water column from deep within the sediment profile and mobilized during dam removal), would also not occur in the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir under the Three Dam Removal Alternative. However, mobilization of approximately 92 to 94 percent the reservoir sediment deposits anticipated to erode under the Proposed Project due to transport of reservoir sediments from Copco No. 1 and Iron Gate reservoirs[224] would still occur in this alternative (see Section 4.6.2.2 *Suspended Sediments*). While there would be some reduction in SSCs downstream of Copco No. 1 due to no sediment being released by J.C. Boyle Dam removal, the overall short-term effects of sediment release and SSCs on sediment-associated oxygen demand and dissolved oxygen concentrations in the Hydroelectric Reach from downstream of Copco No. 1 Dam to Iron Gate Dam under the Three Dam Removal Alternative would still be similar to effects for the Hydroelectric Reach under the Proposed Project in that impact significance associated with SSCs, sediment-associated oxygen demand, and dissolved oxygen concentrations would be the same as the Proposed Project (see Potential Impact 3.2-9 for additional details).

Less sediment would be mobilized into the Middle Klamath River under the Three Dam Removal Alternative, so the extent of downstream increases in oxygen demand (Immediate Oxygen Demand [IOD] and Biological Oxygen Demand [BOD]) and reductions in dissolved oxygen in this reach under the Three Dam Removal Alternative would be somewhat less than those of the Proposed Project. Minimum dissolved oxygen values likely would occur slightly upstream compared the Proposed Project, but they would still generally occur near RM 191 to 193.1 (approximately 0 to 2 miles downstream from Iron Gate Dam) since the location of minimum dissolved oxygen concentrations does not change much with variations in SSCs (see Table 3.2-13). Similarly, the farthest distance downstream with dissolved oxygen less than 5 mg/L likely

[225] Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable.

would shift slightly upstream, but the distance would be similar to the Proposed Project (i.e., approximately RM 145 to 122 or within 48 to 71 miles downstream of Iron Gate Dam) since it does not change much with variations in SSCs. Minimum dissolved oxygen values would likely show a greater relative increase under the Two Dam Removal Alternative compared the Proposed Project, since the amount of IOD and BOD downstream of Iron Gate Dam is strongly influenced by variations in SSCs and there would be less sediment transported under this alternative.

Despite the potential for a slightly shorter distance of short-term impacts due to decreases in the sediment-associated oxygen demand and a reduction in the magnitude of the decrease in dissolved oxygen in the Middle Klamath River under the Three Dam Removal Alternative, the release of sediments trapped behind Copco No. 1 and Iron Gate Dam would decrease dissolved oxygen concentrations in the Klamath River below the Basin Plan water quality objective for dissolved oxygen (90 percent saturation) in the short term and constitute a significant impact. Additionally, since the location where the minimum and at least 5 mg/L dissolved oxygen concentrations occurred during modeling under the Proposed Project did not change much with variations in SSC, it is conservatively estimated that the distance that the significant impact from short-term increase in sediment-associated oxygen demand and reductions in dissolved oxygen under the Three Dam Removal Alternative occurs would be similar to that modeled under the Proposed Project (Potential Impact 3.2-9), so the short-term impact would remain significant in the Middle Klamath River from Iron Gate Dam to approximately the confluence with the Salmon River (RM 66).

Similarly, it is conservatively estimated that the distance where there would be no significant impact on dissolved oxygen from releases of reservoir deposited sediments under the Three Dam Removal Alternative would be similar to that modeled under the Proposed Project. Modeling under the Proposed Project indicates that downstream of the confluence with the Salmon River on the Middle Klamath River, as well as in the Lower Klamath River and the Klamath River Estuary, there would be no significant impact from the release of sediments trapped behind the Lower Klamath Project dams (see Section 3.2.5.4 *Dissolved Oxygen*). Thus, there also would be no significant impact under the Three Dam Removal Alternative downstream of the confluence with the Salmon River on the Middle Klamath River, as well as in the Lower Klamath River and the Klamath River Estuary.

In the long term, since J.C. Boyle Dam would remain in place, continuing summertime interception and retention of sediments and suspended materials from upstream sources containing high biological oxygen demand (see also 3.2.2.5 *Dissolved Oxygen*) would still occur in J.C. Boyle Reservoir under the Three Dam Removal Alternative. Accordingly, existing large summertime variations in dissolved oxygen in J.C. Boyle Reservoir, especially at depth, would still occur and could continue to influence dissolved oxygen concentrations in the California portion of the Hydroelectric Reach in the same manner as under existing conditions (see also 3.2.2.5 *Dissolved Oxygen*). Modeling of existing conditions indicates these summertime dissolved oxygen variations in J.C. Boyle increase the range of dissolved oxygen concentrations between the Oregon-California state line and the upstream end of Copco No. 1 Reservoir (North Coast Regional Board 2011), but aeration and fast water velocities within the free-flowing reach result in dissolved oxygen concentrations near or slightly greater than saturation upstream of Copco No. 1 Reservoir (FERC 2007; Raymond 2008). The Three Dam Removal Alternative would not include peaking power generation and release of flow for recreation at J.C. Boyle Dam, but the dissolved oxygen at the Oregon-California state line would still likely have slightly greater daily variability than natural conditions (see also Potential Impact 3.2-10). While the degree of influence of peaking flows on daily variability in dissolved oxygen concentrations at the Oregon-California state line is not clearly defined by existing information, the daily variability is not currently adversely affecting beneficial uses. However, dissolved oxygen concentrations immediately downstream of J.C. Boyle would potentially fall below 85 percent saturation and 6.5 mg/L during summer similar to existing conditions. Thus, retaining J.C. Boyle with no peaking or recreation flows under the Three Dam Removal Alternative would have only a small influence on dissolved oxygen concentrations downstream of the Oregon-California state line compared to existing conditions and there would be no significant impact.

Within the Hydroelectric Reach downstream of Copco No. 1 Reservoir, the long-term effects of the Three Dam Removal Alternative on dissolved oxygen concentrations would be the same as effects described for the Proposed Project (Potential Impact 3.2-10) as conversion of Copco No. 1, Copco No. 2, and Iron Gate reservoirs to free-flowing riverine reaches with higher velocities and more turbulent mixing would increase aeration of Klamath River. Additionally, the extreme super-saturated surface water and oxygen-depleted hypolimnion conditions found in existing conditions in April/May to October/November would not occur under the Three Dam Removal Alternative as Copco No. 1 and Iron Gate reservoirs would be removed (see Section 3.2.5.4 *Dissolved Oxygen* for details). The long-term effects of dam removal on concentrations of dissolved oxygen in the Middle and Lower Klamath, the Klamath River Estuary, and the Pacific Ocean nearshore environment under the Three Dam Removal Alternative would also be the same as those described for the Proposed Project, where even assuming full TMDL compliance, modeling results[226] indicate that the conversion of Copco No. 1 and Iron Gate reservoirs to free-flowing river reaches would eliminate seasonal extremes in dissolved oxygen concentrations downstream of Iron Gate Dam (see Section 3.2.5.4 *Dissolved Oxygen* for details).

In summary, relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on increased IOD and BOD and dissolved oxygen would be the same as or similar to those described for the Proposed Project, except as follows:

- There would be no short-term increases in IOD and BOD or reductions in dissolved oxygen in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir since sediment deposits in J.C. Boyle Dam would remain in place (Potential Impact 3.2-9). However, there would be no change from the Proposed Project downstream of Copco No. 1 Dam because short-term increases in IOD and BOD and reductions in dissolved oxygen due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams[220] (Potential Impact 3.2-9) would result in a significant and unavoidable impact in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle Klamath River from Iron Gate Dam to the confluence with the Salmon River (RM 66) under the Three Dam Removal Alternative. There would be no significant impact in the Middle Klamath River downstream from the Salmon River

[226] While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*).

confluence, Lower Klamath River, and the Klamath River Estuary under the Three Dam Removal Alternative, similar to the Proposed Project. The short-term significant impact of increases in IOD and BOD and reductions in dissolved oxygen due to release of sediments in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, and the Klamath River Estuary cannot be avoided or substantially decreased through reasonably feasible mitigation.

- Potential long-term alterations in daily variability of dissolved oxygen concentrations in the Hydroelectric Reach in California due to the elimination of hydropower peaking flows at J.C. Boyle Dam (Potential Impact 3.2-10) would result in no significant impact. However, long-term increases in dissolved oxygen, as well as increased daily variability in dissolved oxygen, due to conversion of the Copco No. 1 and Iron Gate reservoirs to a free-flowing river (Potential Impact 3.2-10) would be the same under the Three Dam Removal Alternative as under the Proposed Project. Thus, there would be no significant impact for daily fluctuations in the Hydroelectric Reach between Copco No. 1 and Iron Gate Dam and the Middle Klamath River immediately downstream of Iron Gate Dam, would be beneficial for elimination of summer and fall extremes in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam, and would result in no significant impact in the Lower Klamath River and Klamath River Estuary.

4.6.2.5 pH

In general, the Three Dam Removal Alternative would have the same or similar potential impacts on pH as those identified under the Proposed Project. Because J.C. Boyle Reservoir peaking power generation and whitewater recreation flows downstream of J.C. Boyle Dam do not substantially alter pH in the downstream river under existing conditions, leaving this dam in place and ceasing peaking and recreation flows would be unlikely to affect pH relative to existing conditions in either the short-term or long-term. Under the existing condition in Copco No. 1 and Iron Gate reservoirs, seasonal and daily pH is characterized by high pH (greater than 9 s.u.) and large (0.5 to 1.5 s.u.) daily fluctuations occurring in reservoir surface waters during periods of intense phytoplankton blooms (see Section 3.2.2.6 *pH*). Klamath River TMDL modeling[227] for the Proposed Project indicates that removal of these two reservoirs, which would occur under the Three Dam Removal Alternative, would eliminate the occurrences of high pH and large daily fluctuations in pH in these reaches, because the free-flowing reaches of the river replacing these reservoirs would not support the intense phytoplankton blooms that are driving the existing pH conditions (see Section 3.2.5.5 *pH*). The most significant action to achieve California TMDL compliance is the removal of Copco No. 1, Copco No. 2 and Iron Gate dams as their removal provides lasting long-term benefits to water quality in California. Similar to the Proposed Project, the Three Dam Removal Alternative leads to improved pH conditions and contributes to TMDL compliance on a shorter timeline scale than expected under existing conditions. Due its small size and low retention time, Copco No. 2 Reservoir does not affect pH under existing conditions and its removal under the Three Dam Removal Alternative also would not affect pH within the

[227] While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*).

Hydroelectric Reach or downstream reaches. In the Klamath River downstream from Iron Gate Dam, pH conditions under the Three Dam Removal Alternative would be the same as under the Proposed Project (Potential Impact 3.2-11).

In summary, relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on pH would be the same as or similar to those as described for the Proposed Project (Potential Impact 3.2-11). Thus, there would be no significant impact in the short term or long-term to pH in the Hydroelectric Reach between J.C. Boyle Dam and the upstream end of Copco No. 1 Reservoir since J.C. Boyle Reservoir does not substantially alter pH in the river downstream from this dam under existing conditions (Potential Impact 3.2-11). Short-term and long-term decreases in summertime pH and daily pH fluctuations due to a conversion of the Copco No. 1 and Iron Gate reservoir areas to a free-flowing river (Potential Impact 3.2-11) would be beneficial for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, and would have no significant impact for the Middle Klamath River, the Lower Klamath River, and the Klamath River Estuary.

4.6.2.6 Chlorophyll-a and algal toxins

In general, the Three Dam Removal Alternative would have the same or similar potential impacts on chlorophyll-*a* and algal toxins as those identified under the Proposed Project (see Section 3.2.5.6 *Chlorophyll-a and Algal Toxins*). The shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days at average flows) of J.C. Boyle Reservoir does not promote the low mixing conditions or thermal stratification that create optimal habitat for phytoplankton growth, so the reservoir does not have large phytoplankton blooms (as measured by chlorophyll-*a*) under existing conditions (see Figure 3.2-5). Under existing conditions, peaking power generation flows occur in the late afternoons and early evenings to meet high power demand, and J.C. Boyle Reservoir refills during the night when power demand is minimal. Daily fluctuations in the reservoir water level under existing operations increases mixing in the reservoir, making the reservoir slightly less suitable habitat for phytoplankton during the season of maximum phytoplankton and cyanobacteria (blue-green-algae) growth in the system. Ceasing peaking power generation flows would reduce daily reservoir water level fluctuations in J.C. Boyle Reservoir because the facility would no longer be operated to draw on reservoir storage to support daily peaks in hydropower production when there is not sufficient river flow for peak production (3,000 cfs), as occurs during the summer and fall low flow period under existing conditions. However, the residence time of J.C. Boyle Reservoir without peaking operations would still be short (i.e., on the order of one to three days), so leaving this dam in place and ceasing peaking flows would be unlikely to create conditions that would support large seasonal phytoplankton blooms or increase chlorophyll-*a* concentrations relative to existing conditions. Concentrations of the algal toxin microcystin are generally low in J.C. Boyle Reservoir (Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*) and in the Hydroelectric Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir since the J.C. Boyle Reservoir does not support large blooms of toxigenic blue-green algae and springs downstream of J.C. Boyle Dam dilute any algal toxins that may be present within that reach. Thus, leaving J.C. Boyle Dam in place and ceasing peaking flows associated with the Three Dam Removal Alternative would not promote conditions that would support production of algal toxins.

In Copco No. 1 and Iron Gate reservoirs, existing conditions for chlorophyll-*a* levels in summer and early fall can be two to 10 times greater than those recorded in the mainstem river upstream of Copco No. 1 Reservoir near Shovel Creek. High chlorophyll-*a* readings in the reservoirs as compared to the Klamath River are in part due to the lower mixing conditions and longer residence times of these reservoirs (10.7 days for Copco No. 1 and 14.8 days for Iron Gate at average flows) that promote the growth of phytoplankton and the associated production of chlorophyll-*a* within the reservoirs. Additionally, measurements of microcystin in Copco No. 1 and Iron Gate during summer months show high microcystin concentrations, especially during algal blooms when microcystin concentrations measured between 2006 and 2015 exceeded the State Water Board et al. (2010, updated 2016) 0.8 ug/L and peaked from 64 ug/L in Iron Gate Reservoir to 73,000 ug/L in Copco No. 1 Reservoir (Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*). Under the Three Dam Removal Alternative, elimination of Copco No.1 and Iron Gate reservoirs, which currently support growth conditions for toxin-producing nuisance algal species such as *Microcystis aeruginosa,* would result in decreases in high seasonal concentrations of chlorophyll-*a* and periodically high levels of algal toxins generated by suspended blue-green algae, consistent with the Proposed Project (see Section 3.2.5.6 *Chlorophyll-a and Algal Toxins*). The removal of Copco No. 1 and Iron Gate reservoirs also would eliminate the primary habitat for blue-green algae in the Hydroelectric Reach, reducing both the amount of blue-green algae present that could contribute to chlorophyll-*a* and algal toxins within this reach and the amount of blue-green algae that may be exported into the Klamath River downstream of Iron Gate Dam. Due its small size and low residence time (less than a day), Copco No. 2 Reservoir does not promote phytoplankton growth that would alter chlorophyll-*a* and algal toxins concentrations under existing conditions and its removal under the Three Dam Removal Alternative also would not affect chlorophyll-*a* and algal toxins within the Hydroelectric Reach or downstream reaches.

Because phytoplankton and the resulting chlorophyll-*a* and algal toxin levels (e.g., microcystin) are primarily internally generated in Copco No. 1 and Iron Gate reservoirs, removal of these reservoirs under the Three Dam Removal Alternative would also reduce the transport of chlorophyll-a and algal toxins to the Klamath River downstream of Iron Gate Dam in both the short-term and the long-term, consistent with the Proposed Project.

In summary, relative to existing conditions, the potential impacts and impacts of the Three Dam Removal Alternative on chlorophyll-*a* and algal toxins would be the same as or similar to those described for the Proposed Project, except as follows:

- There would be no short-term or long-term alterations in chlorophyll-a and algal toxins in the Hydroelectric Reach between J.C. Boyle Dam and the upstream end of Copco No. 1 Reservoir since J.C. Boyle Reservoir would remain in place, but it does not support conditions promoting large phytoplankton blooms and associated chlorophyll-a and algal toxins under existing conditions (Potential Impact 3.2-12). However, short-term and long-term reduction of chlorophyll-a and algal toxin levels due to a conversion of the reservoir areas to a free-flowing river (Potential Impact 3.2-12) under the Three Dam Removal Alternative would be beneficial for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, the Middle Klamath River, Lower Klamath River, and Klamath River Estuary, similar to the Proposed Project.

4.6.2.7 Inorganic and Organic Contaminants

Short-term mobilization of J.C. Boyle reservoir sediment deposits would not occur under the Three Dam Removal Alternative and none of the associated 1,190,000 cubic yards of deposits (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches. However, mobilization of reservoir sediment deposits in the much larger Copco No. 1 and Iron Gate reservoirs[228] would still occur such that the short-term potential for mobilization of inorganic and organic contaminants in the Hydroelectric Reach from downstream of Copco No. 1 Dam to Iron Gate Dam under the Three Dam Removal Alternative would be similar to effects for the Hydroelectric Reach under the Proposed Project (Section 3.2.5.7 *Inorganic and Organic Contaminants*).

Though toxicity testing of sediments from J.C. Boyle Resources suggested potential for toxicity to freshwater benthic organisms (when compared to Copco No 1 and Iron Gate reservoir sediments), dilution and dispersals of sediments as expected in the Proposed Project were anticipated to not result in a significant impact to benthic organism survival (Section 3.2.5.7 *Inorganic and Organic Contaminants*). The Three Dam Removal Alternative does not involve the release of J.C. Boyle reservoir sediment deposits thus the potential for toxicity to freshwater benthic organisms may be relatively slightly less under the Three Dam Removal Alternative than that of the Proposed Project due to no sediment from J.C. Boyle Reservoir being transported downstream. However, the overall impact of the release of sediments trapped behind Lower Klamath Project dams, including J.C. Boyle Dam, under the Three Dam Removal Alternative and under the Proposed Project are expected to be similar. The Proposed Project analysis assumes mixing of sediment deposits from all three reservoirs as they move downstream and exposure of downstream aquatic biota to an "average" sediment composition, rather than a reservoir-specific composition (Section 3.2.5.7 *Inorganic and Organic Contaminants*), so overall water column toxicity due to the concentration of inorganic or organic substances under the Proposed Project is unlikely. As such, there would be a less than significant impact due to the release of sediments trapped behind Lower Klamath Project dams, including J.C. Boyle Dam, under the Proposed Project. While leaving J.C. Boyle Dam in place and not releasing J.C. Boyle reservoir deposited sediments would potentially slightly reduce toxicity to benthic freshwater organisms, the overall impact from the release of Copco No. 1 and Iron Gate reservoir deposited sediments and the sediment-associated inorganic and organic contaminants would be a less than significant impact in the short term under the Three Dam Removal Alternative, similar to the Proposed Project.

Although leaving J.C. Boyle Dam in place, removing the existing fish ladder and installing a new fish ladder, would be less construction than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to resources in California since J.C. Boyle is located in Oregon. Thus, short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration activities under the Three Dam Removal Alternative would also be the same as or similar to those described for the Proposed Project.

[228] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

In the long term, existing inorganic and organic contaminant data characterizing J.C. Boyle Reservoir sediment deposits indicate that a relatively small number of chemicals (i.e., mercury, DDTs, and possibly dioxin-like chemicals) are present at levels that have the potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) to freshwater aquatic species remaining in this reservoir under the Three Dam Removal Alternative. Elutriate sediment sample bioassay results from J.C. Boyle Reservoir indicate that no further dilution would be required to prevent water column toxicity to freshwater fish. Relative to existing condition, there would be no change. Conversely, long-term retention of inorganic and organic contaminants contained within existing sediment deposits behind Copco No. 1 and Iron Gate dams and their potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) would not occur since they would be removed under the Three Dam Removal Alternative, which would be beneficial.

In summary, relative to existing conditions the potential impacts of the Three Dam Removal Alternative on inorganic and organic contaminants would be the same as or similar to those described for the Proposed Project, except as noted below:

- J.C. Boyle Reservoir sediment deposits and its sediment-associated inorganic and organic contaminants would not be released downstream, but the short-term and long-term human exposure to inorganic and organic contaminants due to release of sediments currently trapped behind the Lower Klamath Project dams (Potential Impact 3.2-13) would result in a potentially significant impact for the Hydroelectric Reach, Middle Klamath River, Lower Klamath River, and Klamath River Estuary. Implementation of mitigation measures WQ-2 and WQ-3 would result in no significant impact.
- While J.C. Boyle Reservoir sediment deposits and its sediment-associated inorganic and organic contaminants would not be released downstream, the short-term and long-term freshwater aquatic species' exposure to inorganic and organic contaminants due to release of sediments currently trapped behind the Copco No. 1 and Iron Gate dams (Potential Impact 3.2-14) would result in no significant impact for the Hydroelectric Reach, Middle Klamath River, Lower Klamath River, Klamath River Estuary, and Pacific Ocean nearshore environment based on sediment screening and/or laboratory toxicity results after consideration of dilution conditions under the Proposed Project.
- Short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration activities (Potential Impact 3.2-15) in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam would be potentially significant without mitigation. Implementation of mitigation measures WQ-1, TER-1, and HZ-1 would result in no significant impact.
- Short-term impacts to aquatic biota from herbicide application during restoration of the reservoir footprint area (Potential Impact 3.2-16) would be potentially significant without mitigation. Implementation of Mitigation Measure WQ-4 would result in no significant impact.
- Long-term freshwater aquatic species' exposure to inorganic and organic contaminants contained within J.C. Boyle Reservoir sediment deposits would continue to have the potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) to some freshwater aquatic species in the reservoir

(Potential Impact 4.2.2-8), which would be no significant impact (no change from existing adverse conditions).

4.6.2.8 General Water Quality

Iron Gate Hatchery operations would continue, and Fall Creek Hatchery would reopen, for eight years under the Three Dam Removal Alternative. The potential short-term and long-term impacts of these operations on the Klamath River, Bogus Creek, and Fall Creek water quality would be the same as described for the Proposed Project (Potential Impact 3.2-17).

4.6.3 Aquatic Resources

4.6.3.1 Suspended Sediment

As discussed in Section 4.6.2.2 *Suspended Sediments*, while there would be some reduction in SSCs downstream of Copco No. 1 due to no SSCs being released by J.C. Boyle Dam removal, the reduction of SSCs under the Three Dam Removal Alternative would not alter the overall impact of dam removal on SSCs compared to the Proposed Project in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, or the nearshore marine environment. Thus, the potential impacts of suspended sediment on aquatic resources in California would be the same under the Three Dam Removal Alternative as those described under the Proposed Project (see also Section 3.3.5.1 *Suspended Sediment*).

4.6.3.2 Bed Elevation and Grain Size Distribution

Because the volume of stored sediment in J.C. Boyle Reservoir is relatively small compared with the volume of stored sediment in Copco No. 1 and Iron Gate reservoirs, the potential for alterations in bed elevation and grain size distribution and the associated effects on aquatic resources in California would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (see also Section 3.3.5.2 *Bed Elevation and Grain Size Distribution*). Thus, downstream impacts to aquatic species due to bed elevation and grain size distribution would be very similar to those described for the Proposed Project.

4.6.3.3 Water Quality

California would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (see also Section 3.3.5.3 *Water Quality*). As Copco No. 1 and Iron Gate reservoirs are the largest of the four Lower Klamath Project reservoirs, they have the greatest impact on water quality (FERC 2007), and their removal would result in water quality conditions similar to those of the Proposed Project. Because of its small size and short residence time, continuing to store water within J.C. Boyle Reservoir would generally not result in the same poor water temperature conditions that occur downstream of the larger Lower Klamath Project reservoirs under existing conditions. Section 4.6.2 discusses the impacts of the Three Dam Removal Alternative with an emphasis on similarities and differences with the potential impacts of the Proposed Project.

The Three Dam Removal Alternative includes no peaking power generation or release of flow for recreation at J.C. Boyle Dam. As described in Section 3.2.2.2 *Water Temperature*, daily peaking operations at J.C. Boyle Powerhouse (RM 225.2) result in an increase in the daily water temperature range in the Bypass Reach because warmer reservoir discharges are diverted around this reach and cold groundwater springs enter the river and dominate remaining flows. The temperature effects of altering the flow regime under the Three Dam Removal Alternative (while keeping J.C. Boyle Dam in place) would be a reduction in diel (24-hour) temperature variation and overall warmer water temperatures in the Bypass Reach during summer and early fall. In the Peaking Reach, water temperature effects would be the same as under the Proposed Project (i.e., slightly lower maximum water temperatures and less artificial diel [24-hour] temperature variation during summer and early fall) since no peaking flows would occur and the effect of J.C. Boyle thermal mass on water temperatures does not extend this far downstream (see also Section 4.6.2.1 *Water Temperature*).

In the Hydroelectric Reach from the upstream end of Copco No. 1 Reservoir to Iron Gate Dam, removing Iron Gate, Copco No. 1, and Copco No. 2 reservoirs and converting the reservoir areas to a free-flowing river under this alternative would result in the same effects on water temperatures in the Middle Klamath River immediately downstream from Iron Gate Dam as described for the Proposed Project (i.e., long-term increases in spring water temperatures and decreases in late summer/fall water temperatures) (see Section 3.3.5.3 *Water Quality*).

4.6.3.4 Fish Disease and Parasites

For the reasons discussed below, potential impacts of fish disease and parasites on aquatic resources in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.5 *Fish Disease and Parasites*). The main factors contributing to risk of juvenile salmonid infection by *C. shasta* and *P. minibicornis* include availability of habitat (pools, eddies, and sediment) for the polychaete intermediate host; microhabitat characteristics (static flows and low velocities); congregations of spawned adult salmon with high spore; polychaete proximity to spawning areas; planktonic food sources from Lower Klamath Project reservoirs; and water temperatures greater than 59°F (Bartholomew and Foott 2010). The current reach with highest infectivity (nidus) for *C. shasta* and *P. minibicornis* is located in the Klamath River downstream of Iron Gate Dam, where returning adult spawners congregate. For adult salmon, Ich and columnaris have occasionally resulted in substantial mortality, particularly when habitat conditions include exceptionally low flows, high water temperatures, and high densities of fish (such as adult Chinook salmon migrating upstream in the fall and holding at high densities in pools). This section addresses differences between these disease factors anticipated under the Three Dam Removal Alternative in comparison with the Proposed Project, and implications for effects on juvenile and adult salmonid life stages.

The availability of habitat for the polychaete worm intermediate host is driven by sediment transport and hydrologic dynamics that as described in sections above would be nearly the same as the Proposed Project. The relatively low volume of sediment in J.C. Boyle Reservoir would not appreciably affect habitat for the polychaete host relative to the Proposed Project, and thus the hydrology affecting microhabitat characteristics would be the same as that described for the Proposed Project. The reduction in congregations of spawned adults with proximity to polychaetes would be similar to the

Proposed Project, since anadromous salmonids would have upstream migratory access past Iron Gate Dam, including provision of improved fish passage at J.B. Boyle Dam, and would be as widely distributed. As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing and emergency dilution flows are required to be released from Iron Gate Dam prior to reconsultation on the 2013 BiOp Flows, but they are not modeled as part of existing conditions hydrology. Under the Three Dam Removal Alternative, it is anticipated that the nidus would no longer form downstream of Iron Gate Dam, and the risk of a new nidus forming upstream is low, even in the absence of the 2017 flow requirements (see also Section 3.3.5.5 *Fish Disease and Parasites*). Although the conditions leading to a reach that would exhibit the highest infectivity (nidus) for *C. shasta* and *P. minibicornis* downstream of Iron Gate Dam would be ameliorated once Copco No. 1, Copco No. 2, and Iron Gate dams are removed, some disease factors would continue under the Three Dam Removal Alternative, including eight years of additional Iron Gate Hatchery operations potentially resulting in continued (through post-dam removal year 10) congregations of mostly adult fall-run Chinook salmon in the reach from Iron Gate Dam to Seiad Valley (see also Section 3.3.5.6 *Fish Hatcheries*). Under the Three Dam Removal Alternative, if a nidus were to remain in the vicinity of Iron Gate Hatchery, or theoretically were to form within newly accessible upstream habitat such as the reach immediately downstream of J.C. Boyle Dam where a future fish passage facility entrance would be located, flushing and emergency dilution flows as required by the 2017 court order may be required from a new upstream location to achieve the same ecological benefits (i.e., disruption of nidus).

Under the Three Dam Removal Alternative, planktonic (e.g., floating organisms such as algae) food sources would be reduced relative to existing conditions with elimination of reservoir habitats, similar to conditions under the Proposed Project. However, because J.C. Boyle Reservoir would remain it would continue to provide a source of planktonic food for the polychaete host of *C. shasta* and *P. minibicornis*. Therefore, while planktonic food sources would be reduced under the Three Dam Removal Alternative relative to existing conditions, slightly more reservoir (and thus planktonic food source) would be removed under the Proposed Project.

Conditions resulting in water temperatures greater than 59°F downstream of Iron Gate Dam under the Three Dam Removal Alternative would be the same as those identified under the Proposed Project. As described in Section 4.6.2.1 *Water Temperature*, the presence of the J.C. Boyle Reservoir on the Klamath River does not alter water temperatures in further downstream reaches because it has a shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days) that does not support thermal stratification (FERC 2007).

Under the Three Dam Removal Alternative, the conditions that can support Ich and columnaris outbreaks among adult salmonids (i.e., exceptionally low flows, high water temperatures, and high densities of fish), would be similar to those identified under the Proposed Project, especially within the Lower Klamath River where Ich and columnaris have caused substantial mortality under existing conditions. Downstream of the confluence with the Salmon River neither the Proposed Project or the Three Dam Removal Alternative would have a pronounced effect on instream flows, water temperatures, or congregations of fish, due to the contributions of several large tributaries (notably the Trinity River). Overall, impacts to aquatic species due to fish disease and parasites would improve relative to existing conditions under the Three

Dam Removal Alternative and they would be very similar to those described for the Proposed Project.

4.6.3.5 Fish Hatcheries

The potential impacts of fish hatcheries on aquatic resources in the California portions of the Klamath River would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.6 *Fish Hatcheries*). As neither the Fall Creek nor the Iron Gate hatchery facilities were built to address potential fisheries effects of J.C. Boyle Dam, and this alternative includes volitional fish passage at J.C. Boyle consistent with mandatory conditions issued for relicensing of the Klamath Hydroelectric Project, thereby eliminating J.C. Boyle Dam as a fish barrier, this alternative assumes that hatchery operations would continue for eight years under the Three Dam Removal Alternative and then the hatcheries would be removed. During the eight years following removal of Copco No. 1, Copco No. 2, and Iron Gate dams, the hatcheries would operate with reduced production goals consistent with those described for the Proposed Project (see Section 2.7.6 *Hatchery Operations*).

4.6.3.6 Algal Toxins

Potential impacts of algal toxins on aquatic resources in the California portions of the Klamath River would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.7 *Algal Toxins*). Removal of the larger Copco No. 1 and Iron Gate reservoirs would decrease or eliminate support for excessive growth of phytoplankton, including seasonal blue-green algae blooms and associated algal toxins (e.g., microcystin), by eliminating large areas of quiescent habitat where these phytoplankton species currently thrive. While J.C. Boyle Reservoir would remain, because of its small size (2,267 acre-feet, Table 2.3-1) and short hydraulic residence time (approximately 1 day, Table 3.6-4), it would not support substantial blooms and thus the expected decrease in algal toxins anticipated under the Proposed Project would be the same under the Three Dam Removal Alternative. Additionally, potential for bioaccumulation of algal toxins in freshwater mollusk and fish tissue under the Three Dam Removal Alternative would be expected to decrease in the mainstem Klamath River from Hydroelectric Reach to the Klamath River Estuary as described for the Proposed Project.

4.6.3.7 Aquatic Habitat

For the reasons discussed below, potential impacts of aquatic habitat on aquatic resources in California portions of the Klamath River would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.8 *Aquatic Habitat*). Improvements in aquatic habitat conditions resulting from increased minimum flows and ending peaking operations downstream of J.C. Boyle Dam based on federal mandatory conditions in the PacifiCorp hydroelectric relicensing process would occur under the Three Dam Removal Alternative as described for the Proposed Project. As described in sections above, changes sediment dynamics would also be similar to those described under the Proposed Project. Access to additional aquatic habitat upstream of Iron Gate Dam would be the same under the Three Dam Removal Alternative as described for the Proposed Project, since fish passage would be provided at J.C. Boyle Dam (see also Section 4.6.3.8 *Fish Passage*). The primary difference under the Three Dam Removal Alternative is that aquatic habitat within J.C. Boyle

Reservoir would remain lentic rather than reverting to the riverine conditions described for the Proposed Project. Based on the estimates of Cunanan (2009), there would be approximately 3.5 fewer miles of additional riverine habitat (currently inundated by J.C. Boyle Reservoir) that would become available under this alternative compared to the Proposed Project. However, J.C. Boyle Reservoir inundation is a small proportion (approximately 16 percent) of the 22 miles of Lower Klamath Project reservoir habitat that would be restored to riverine habitat under the Proposed Project. In addition, J.C. Boyle would continue to provide reservoir habitat to support aquatic resources (including shortnose and Lost River suckers), discussed in Potential Impact 3.3-13. Under the Three Dam Removal Alternative, the three lower reservoirs would be removed as described for the Proposed Project, restoring approximately 18.5 miles of mainstem river that previously exhibited high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009).

4.6.3.8 Fish Passage

The current upstream fishway at J.C. Boyle Dam is obsolete and does not meet NMFS (2011) design criteria (U.S. Department of Interior, DOI 2007). Under the Three Dam Removal Alternative, fish would have access beyond the location of Copco No. 1, Copco No. 2, and Iron Gate dams, as described for the Proposed Project (Section 3.3.5.8 *Aquatic Habitat*). However, whereas under the Proposed Project fish would have volitional unimpeded access past J.C. Boyle Dam, under the Three Dam Removal Alternative fish migrating upstream and downstream past J.C. Boyle Dam would access upstream habitat via fishways. DOI (2007) included a prescription for a NMFS-criteria volitional year-round fish ladder at J.C. Boyle Dam to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. In addition, DOI (2007) prescribed a new year-round NMFS criteria fish screen and a bypass facility at J.C. Boyle Dam (and modifications to spillway) to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, redband trout, and listed sucker species. Under the Three Dam Removal Alternative, fishways would be consistent with the prescriptions from the DOI and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007), and specific fishway facility design and construction details included in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*[215], including fishway (i.e., fish ladder and screens) installation for both upstream and downstream migrations and barriers to prevent juvenile salmonid entrainment into turbines. Trap and haul would involve design assumptions described in the Section 4.4. *Continued Operations with Fish Passage Alternative,* but the assumptions would only be applied to J.C. Boyle Dam. In this EIR, it is assumed that for application at one dam (J.C. Boyle Dam), if alternative passage facilities were designed and constructed, they would necessarily meet agency criteria and thus would have an equivalent level of mortality as volitional fishways.

In their preliminary fishway prescriptions for the Lower Klamath Project dams, NMFS (2006) recommended dam removal to FERC under FPA S10(a)and(j) as the environmentally preferred alternative to provide the least mortality and injury to migrating fish. The associated NMFS fishway prescription (DOI 2007) is a mandatory conditioning authority that was submitted during the hydropower relicensing process at the time, in case FERC chose to reject NMFS' strong recommendation to removal all of the Lower Klamath Project mainstem dams. While unimpeded volitional fish passage is assumed to have higher survival and lower injury than fishways, no data or analyses are available to accurately compare the effectiveness of unimpeded fish passage under the Proposed Project with volitional fishways under the Three Dam Removal Alternative. NMFS does not provide an expected level of mortality or injury in association with fishways constructed to their criteria, and performance would depend on many site-specific factors that would be considered in the design phase of new fishways. Based on the measured effectiveness of fishways constructed to NMFS criteria at other dams (DWR 2013), this EIR assumes at least 98 percent survival (or less than 2 percent mortality) of upstream and downstream migrating aquatic species in recognition that while survival could be high at properly constructed facilities, it is unlikely to be as high as survival would be with dams removed (i.e., 100 percent). Regardless of how fish passage is provided, this alternative assumes fish passage consistent with the general prescriptions (DOI 2007) that cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007). This EIR also assumes that effects of passage through volitional fishways would be equivalent for other migratory species, which appears to be a reasonable assumption based on available data (DWR 2013) for fishways designed and constructed to modern agency criteria as required by DOI (2007).

Based on the similarities between the Three Dam Removal Alternative and the Proposed Project for several of the key ecological attributes discussed above, the potential impacts of the Three Dam Removal Alternative would be the same as those described under the Proposed Project for several potential impacts (Potential Impacts 3.3-2, 3.3-3, 3.3-5, 3.3-6, 3.3-12, 3.3-15, 3.3-16, 3.3-18, 3.3-20, 3.3-21, 3.3-22, 3.3-23, and 3.3-24). The potential impacts of the Three Dam Removal Alternative that could result in different effects than those already discussed under the Proposed Project are discussed below.

Potential Impact 3.3-1 Effects on coho salmon critical habitat quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on coho salmon critical habitat in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-1), with a few subtle differences. For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on critical habitat from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles. Habitat in the J.C. Boyle Bypass and Peaking Reaches would be improved through elimination of peaking operations and higher baseflows. Therefore, although upstream of current designated critical habitat, the Three Dam Removal Alternative would expand the geographic extent of habitat available to coho salmon in a similar manner to the Proposed Project.

The short-term impacts on coho salmon critical habitat from sediment releases would be the same under the Three Dam Removal Alternative as those described for the

Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-1), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Based on the substantial short-term decrease in quality of the features of critical habitat and PCEs supporting SONCC coho salmon, there would be a significant impact to coho salmon critical habitat under the Three Dam Removal Alternative in the short term.

However, as described for the Proposed Project, the Three Dam Removal Alternative includes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) to reduce the short-term effects of SSCs on coho salmon PCEs of critical habitat. In addition, mitigation measures AQR-1 and AQR-2 (described in Section 3.3.5.9 *Aquatic Resource Impacts*), would be implemented to increase certainty of the effectiveness of the aquatic resource measures AR-1 and AR-2 and reduce the short-term significant adverse impacts of the Three Dam Removal Alternative on coho salmon critical habitat. Consistent with the Proposed Project, based on the wide distribution of coho salmon critical habitat within tributaries, aquatic resource measures, and mitigation measures designed to offset short-term impacts to PCEs of critical habitat, there would not be a substantial decrease in the quality of a substantial proportion of habitat for coho salmon critical habitat in the short term. Therefore, the Three Dam Removal Alternative would have no significant impact on coho salmon critical habitat in the short term.

For the reasons described in Section 4.6.3.7 *Aquatic Habitat*, in the long term the Three Dam Removal Alternative would increase the amount of habitat available to coho salmon upstream of currently designated critical habitat and improve water quality and bedload characteristics in the mainstem Klamath River within current critical habitat in the same manner as the Proposed Project. Overall, these changes would be a substantial increase in the quality and quantity of coho salmon critical habitat in the long term as compared to existing conditions. Therefore, the Three Dam Removal Alternative would be beneficial for coho salmon critical habitat in the long term.

Significance

No significant impact with mitigation to coho salmon critical habitat in the short term

Beneficial for coho salmon critical habitat in the long term

Potential Impact 3.3-4 Effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on Chinook and coho salmon EFH in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-4), with a few subtle differences. For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on EFH from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

The short-term impacts on Chinook and coho salmon EFH from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-4), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Based on the substantial short-term decrease in quality of EFH for Chinook and coho salmon, there would be a significant impact to Chinook and coho salmon EFH under the Three Dam Removal Alternative in the short term.

However, as described for the Proposed Project, the Three Dam Removal Alternative includes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) to reduce the short-term effects of SSCs on Chinook and coho salmon EFH. In addition, mitigation measures AQR-1 and AQR-2 (described in Section 3.3.5.9), would be implemented to increase certainty of the effectiveness of the aquatic resource measures AR-1 and AR-2 and reduce the short-term significant adverse impacts of the Three Dam Removal Alternative on Chinook and coho salmon EFH. Consistent with the Proposed Project, based on the wide distribution and use of tributaries by both juvenile and adult Chinook and coho salmon, aquatic resource measures (AR-1 and AR-2), and mitigation measures (AQR-1 and AQR-2), designed to offset short-term impacts to Chinook and coho salmon EFH, there would not be a substantial decrease in the quality of a large proportion of Chinook and coho salmon EFH in the short term. Therefore, the Three Dam Removal Alternative would have no significant impact, with mitigation, on Chinook and coho salmon EFH in the short term.

For the reasons described above in Section 4.6.3.7 *Aquatic Habitat*, in the long term the Three Dam Removal Alternative would increase habitat for Chinook and coho salmon (upstream of currently designated EFH) by providing access to habitats upstream of Iron Gate Dam in the same manner as the Proposed Project. Overall, these changes would be a substantial increase in the quality and quantity of Chinook and coho salmon EFH in the long term. Therefore, the Three Dam Removal Alternative would be beneficial for Chinook and coho salmon EFH in the long term.

Significance

No significant impact with mitigation to Chinook and coho salmon EFH in the short term

Beneficial for Chinook and coho salmon EFH in the long term

Potential Impact 3.3-7 Effects on the fall-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on fall-run Chinook salmon in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-7), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on fall-run Chinook salmon from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Based on the 440 miles of fall-run Chinook salmon habitat estimated upstream of Iron Gate Dam (Section 3.3.5.8 *Aquatic Habitat*), the 3.5 miles that would remain inundated by J.C. Boyle Reservoir rather than reverting to riverine habitat under the Three Dam Removal Alternative is not substantial (< 1 percent of newly accessible habitat). Juvenile Chinook salmon would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles. Therefore, due to loss in fish passage facilities and migration through reservoir habitat, the estimated increases in fall-run Chinook salmon abundance predicted to occur under the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-7), would be less under the Three Dam Removal Alternative.

The short-term impacts on fall-run Chinook salmon from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-7), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. As described for the Proposed Project (Potential Impact 3.3-7), because there would be no substantial short-term decrease in fall-run Chinook salmon abundance of a year class, and no substantial decrease in habitat quality or quantity, there would not be a significant impact to fall-run Chinook salmon under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on fall-run Chinook salmon In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including fall-run Chinook salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Three Dam Removal Alternative on fall-run Chinook salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase habitat availability, restore a more natural flow regime and seasonal water temperature variation, improve water quality, and reduce the likelihood of fish disease and algal toxins, all of which would be beneficial for fall-run Chinook salmon in the same manner as the Proposed Project. Overall, the multiple benefits of the Three Dam Removal Alternative would be beneficial for fall-run Chinook salmon in the long term.

Significance

No significant impact for fall-run Chinook salmon populations in the short term

Beneficial for fall-run Chinook salmon populations in the long term

Potential Impact 3.3-8 Effects on the spring-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on spring-run Chinook salmon in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-8), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on spring-run Chinook salmon from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Based on the 440 miles of spring-run Chinook salmon habitat estimated upstream of Iron Gate Dam (Section 3.3.5.8 *Aquatic Habitat*), the 3.5 miles that would remain inundated by J.C. Boyle Reservoir rather than revert to riverine habitat under the Three Dam Removal Alternative is unsubstantial (< 1 percent of newly accessible habitat). Juvenile Chinook salmon would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

The short-term impacts on spring-run Chinook salmon from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-8), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. As described for the Proposed Project (Potential Impact 3.3-8), because there would not be a substantial short-term decrease in spring-run Chinook salmon abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to spring-run Chinook salmon under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on fall-run Chinook salmon In the short term, aquatic resource measure AR-2 (Juvenile Outmigration) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including spring-run Chinook salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measure AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Three Dam Removal Alternative on spring-run Chinook salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase habitat availability, restore a more natural flow regime and seasonal water temperature variation, improve water quality, and reduce the likelihood of fish disease and algal toxins, all of which would be beneficial for spring-run Chinook salmon in the same manner as the Proposed Project. Overall, the multiple benefits of the Three Dam Removal Alternative would be beneficial for spring-run Chinook salmon in the long term.

Significance

No significant impact for spring-run Chinook salmon populations in the short term

Beneficial for spring-run Chinook salmon populations in the long term

Potential Impact 3.3-9 Effects on coho salmon populations due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on coho salmon in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-9), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on coho salmon from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion (approximately 80 miles) expected under the Proposed Project (as described in Section 3.3.5.8 *Aquatic Habitat*) would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Juvenile coho salmon would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles. Habitat in the J.C. Boyle Bypass and Peaking Reaches would be improved through elimination of peaking operations and higher baseflows. Therefore, the Three Dam Removal Alternative would expand the geographic extent of habitat available to coho salmon in a similar manner to the Proposed Project; albeit with higher migration mortality in fishways and reservoirs.

The short-term impacts on coho salmon from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-9), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Because there would not be a substantial short-term decrease in coho salmon abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to coho salmon under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on coho salmon In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including coho salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Three Dam Removal Alternative on coho salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase the amount of habitat available to coho salmon and improve water quality and bedload characteristics in the mainstem Klamath River in the same manner as the Proposed Project. Overall, these changes could result in a substantial increase the abundance of coho salmon populations in the long term. Therefore, the Three Dam Removal Alternative would be beneficial for coho salmon in the long term.

Significance

No significant impact for coho salmon populations in the short term

Beneficial for coho salmon populations in the long term

Potential Impact 3.3-10 Effects on the steelhead population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on steelhead in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-10), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on steelhead from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion (approximately 440 miles) expected under the Proposed Project (as described in Section 3.3.5.8 *Aquatic Habitat*) would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Juvenile steelhead would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

The short-term impacts on steelhead from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-10), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Because there would not be a substantial short-term decrease in steelhead abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to steelhead under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on steelhead In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including steelhead. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Three Dam Removal Alternative on steelhead by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase the amount of habitat available to steelhead and improve water quality and bedload characteristics in the mainstem Klamath River in the same manner as the Proposed Project. Overall, these changes could result in a substantial increase the abundance of steelhead populations in the long term. Therefore, the Three Dam Removal Alternative would be beneficial for steelhead in the long term.

Significance

No significant impact for steelhead populations in the short term

Beneficial for steelhead populations in the long term

Potential Impact 3.3-11 Effects on the Pacific lamprey population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on Pacific lamprey in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-11), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on Pacific lamprey from sediment releases would be similar to the Proposed Project, as well as water quality, and algal toxins. The same habitat expansion (approximately 80 miles) expected under the Proposed Project (as described in Section 3.3.5.8 *Aquatic Habitat*) would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would continue to be inundated by J.C. Boyle Reservoir and unlikely to be used by Pacific Lamprey. Based on the 80 miles of Pacific lamprey habitat estimated upstream of Iron Gate Dam (Section 3.3.5.8 *Aquatic Habitat*), the 3.5 miles that would remain inundated by J.C. Boyle Reservoir rather than revert to riverine habitat under the Three Dam Removal Alternative is unsubstantial (< 5 percent of newly accessible habitat). Juvenile lamprey would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

The short-term impacts on Pacific lamprey from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-11), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Because there would not be a substantial short-term decrease in Pacific lamprey abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to Pacific lamprey under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on Pacific lamprey In the short term, aquatic resource measure AR-1 (Mainstem Spawning) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on Pacific lamprey. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measure AQR-1, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Three Dam Removal Alternative on Pacific lamprey by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase the amount of habitat available to Pacific lamprey and improve water quality and bedload characteristics in the mainstem Klamath River in the same manner as the Proposed Project. Overall, these changes could result in a substantial increase the abundance of Pacific lamprey populations in the long term. Therefore, the Three Dam Removal Alternative would be beneficial for Pacific lamprey in the long term.

Significance

No significant impact for Pacific lamprey in the short term

Beneficial for Pacific lamprey in the long term

Potential Impact 3.3-12 Effects on the green sturgeon population due to short-term sediment releases and long-term changes in habitat quality due to dam removal.
Southern DPS Green Sturgeon may enter the Klamath River Estuary to forage during the summer months. They would not be present when the most severe effects of dam removal are occurring and are not expected to be affected by the Three Dam Removal

Alternative. The remainder of this section focuses on the effects of the Three Dam Removal Alternative on the Northern Green Sturgeon DPS. Northern Green Sturgeon do not occur upstream of Ishi Pishi Falls and would not be affected by Three Dam Removal Alternative impacts that do not extend downstream past these falls. Potential impacts on green sturgeon in California would be the same under the Three Dam Removal Alternative as those described for the Proposed Project in the short term (Potential Impact 3.3-12).

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would result in the same improvements in flow regime, water quality, temperature variation, and algal toxins as described for the Proposed Project (Potential Impact 3.3-12). Because there would not be a substantial short- or long-term decrease in green sturgeon abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the green sturgeon population under the Three Dam Removal Alternative in the short or long term.

Significance

No significant impact for green sturgeon in the short or long term

Potential Impact 3.3-13 Effects on Lost River and shortnose sucker populations due to short- and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on Lost River and shortnose suckers in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-13), with a few notable differences. For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on Lost River and shortnose suckers in Upper Klamath Lake, interactions with anadromous fish, and from conversion of Lower Klamath Project reservoir habitat to riverine habitat would be similar to the Proposed Project. Lost River and shortnose suckers currently occur within all Lower Klamath Project reservoirs, including J.C. Boyle Reservoir (Desjardins and Markle 1999). Therefore, while under the Proposed Project all Lower Klamath Project reservoir habitat (2,347 acres) currently supporting Lost River and shortnose suckers would be removed, under the Three Dam Removal Alternative habitat would remain in J.C. Boyle Reservoir (420 acres). Most of the reservoir habitat (82 percent), and the preponderance of the Lost River and shortnose sucker populations in the Hydroelectric Reach is within Iron Gate and Copco reservoirs.

Overall, the short-term impact of the Three Dam Removal Alternative would be very similar to the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-13), with the exception of those Lost River and shortnose sucker individuals that are able to remain within J.C. Boyle Reservoir habitat. All individual suckers occurring within the lower three Lower Klamath Project reservoirs would likely be lost within dam removal year 2; however, these individuals are not considered to substantially contribute to the achievement of conservation goals or recovery, since little or no reproduction occurs downstream from Keno Dam (Buettner et al. 2006), and there is no potential for interaction with upstream populations (Hamilton et al. 2011). Based on the best available estimates of Lost River and shortnose sucker abundance in the Lower Klamath Project excluding J.C. Boyle Reservoir, there are likely fewer than 1,000 adult suckers of both species (USFWS 2012, Desjardins and Markle 1999), with a combined suitable sucker area of less than 2,500 acres. The populations in Upper Klamath Lake are estimated at 50,000 to 100,000 Lost River sucker (USFWS 2013b), and up to 25,000 shortnose suckers (USFWS 2013c), within around 79,000 acres of suitable habitat in Upper Klamath Lake and connected water bodies. Therefore, a loss of the suckers in Lower Klamath Project reservoirs (excluding J.C. Boyle Reservoir) represents around less than 1.5 percent of the total sucker population, and a loss of less than 3.5 percent of the total suitable sucker habitat. Based on no predicted substantial (< 1.5 percent) short-term decrease in Lost River and shortnose suckers' abundance of a year class, or substantial decrease in habitat quality or quantity (<1.5 percent), the Three Dam Removal Alternative would not cause a significant impact to the Lost River and shortnose sucker populations in the short term.

For the reasons described above in Section 4.6.3.7 *Aquatic Habitat*, in the long term reservoir removal associated with dam removal under the Three Dam Removal Alternative would eliminate habitat availability and affect Lost River and shortnose suckers in Iron Gate and Copco reservoirs. All individual suckers occurring within these reservoirs would likely be lost within the short term and would not be replaced in the long term. However, as described above, these individuals are not considered to substantially contribute to the achievement of conservation goals or recovery of the populations (Hamilton et al. 2011). Because there would not be a substantial long-term decrease in Lost River and shortnose suckers abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the Lost River and shortnose sucker populations under the Three Dam Removal Alternative in the long term.

In addition, and as described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-13), although this EIR finds no significant impact on Lost River and shortnose suckers in the short term or long term, aquatic resource measure AR-6 (Suckers) would occur under the Three Dam Removal Alternative, which would further reduce the potential for effects of reservoir removal.

<u>Significance</u>

No significant impact for Lost River and shortnose sucker populations in the short term

No significant impact for Lost River and shortnose sucker populations in the long term

Potential Impact 3.3-14 Effects on the redband trout population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on redband trout in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-14), with a few notable differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6 *Algal Toxins*, impacts on redband trout from water quality would be similar to the Proposed Project, as well as algal toxins. Redband trout would also be affected by the reintroduction of anadromous fish, including the potential for competition, predation, and exposure to disease in the same manner as described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14), since these result from restored habitat access of anadromous salmonids that would not differ between the Proposed Project and the Three Dam Removal Alternative.

Suspended and bedload sediment effects would differ from those described for the Proposed Project. Redband trout are distributed upstream of Iron Gate and Copco reservoirs, and therefore under the Proposed Project the impacts these individuals would experience from sediment releases would be downstream of J.C. Boyle and downstream of Copco No. 1 and Copco No. 2. Therefore, for those individuals upstream of Copco No. 1, despite the relatively small volume of sediment stored in J.C. Boyle Reservoir, impacts of sediment release on redband trout that would occur under the Three Dam Removal Alternative would be substantially less under the Proposed Project. For those individuals downstream of Copco No. 2 the impacts of sediment release would be indistinguishable from the Proposed Project, due to the relatively large contribution from sediment stored in Copco No. 1 Reservoir.

As described in Section 4.6.3.7 *Aquatic Habitat*, conversion of Lower Klamath Project reservoir habitat to riverine habitat would be similar to the Proposed Project, with the exception of J.C. Boyle Reservoir. Under the Three Dam Removal Alternative redband trout would benefit from changes in hydropower operations, and from the conversation of 17.7 miles of reservoir habitat to riverine habitat, in the same manner as for the Proposed Project. However, 3.5 miles of mainstem and tributary habitat would continue to be inundated by J.C. Boyle Reservoir. It is anticipated that under the Three Dam Removal Alternative this habitat would continue to support an adfluvial redband trout population. As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

Because there would not be a substantial short-term decrease in redband trout abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the redband trout population under the Three Dam Removal Alternative in the short term. Based on a long-term substantial increase in redband trout habitat quality and quantity, the Three Dam Removal Alternative would be beneficial for redband trout in the long term.

Significance

No significant impact for redband trout in the short term

Beneficial for redband trout in the long term

Potential Impact 3.3-17 Effects on species interactions between introduced resident fish species and native aquatic species due to short- and long-term changes in habitat quality and quantity due to dam removal.

Introduced fish species threaten the diversity and abundance of native fish species through competition for resources, predation, interbreeding with native populations, and causing potential physical changes to the invaded habitat (Moyle 2002). Potential impacts on species interactions between introduced resident fish species and native aquatic species ("species interactions") in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14), with a few notable differences. As described for the Proposed Project, implementation of the Three Dam Removal Alternative would eliminate reservoir habitat associated with three Lower Klamath Project reservoirs, and thus the abundance of introduced resident species would decline substantially (Buchanan et al. 2011a), providing a benefit to native aquatic species. However, the Three Dam Removal Alternative would retain the habitat supporting non-native fish species associated with

J.C. Boyle Reservoir. As described in Section 3.3.2.1 *Aquatic Species [non-native fish species]*, non-native fish species would continue to occur in J.C. Boyle Reservoir, including yellow perch and bass species. Juvenile salmonids and lamprey would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018). However, in restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (NMFS 2006a). In addition, the majority of the non-native species are within Iron Gate and Copco No. 1 reservoirs, which support popular recreational fisheries for yellow perch and bass. Therefore, species interactions under the Three Dam Removal Alternative would be substantially improved relative to existing conditions, albeit to a lesser degree than under the Proposed Project. This effect would be beneficial for native aquatic species in the short and long term.

<u>Significance</u>
Beneficial for the effects of introduced resident fish species on aquatic species in the short term and long term

Potential Impact 3.3-19 Effects on freshwater mollusks populations due to short-term sediment releases and long-term changes in habitat quality due to dam removal.
Potential impacts on freshwater mollusks in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-19), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment*, impacts on freshwater mollusks from sediment releases would be similar to the Proposed Project. Based on the distribution of freshwater mollusks primarily downstream of Iron Gate dam (summarized in Section 3.3.5.9, Potential Impact 3.3-14), the impacts of the Three Dam Removal Alternative would be the same as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14) with one exception. The Proposed Project would have the most substantial impact on the floater mussels (*Anodata spp*.) which occur in the mainstem Klamath River in the Hydroelectric Reach, within Lower Klamath Project reservoirs, in a reach (<15 miles) directly downstream of Iron Gate Dam, and within the Upper Shasta River. *Anodata spp*. have been found in high abundance within J.C. Boyle Reservoir as recently as summer 2018 (Troy Brandt, River Design Group, pers. comm., November 2018). Therefore, under the Three Dam Removal Alternative the *Anodata spp.* would remain unaffected within a portion of their range in J.C. Boyle Reservoir and Upper Shasta River. Therefore, while the impacts to other species of freshwater mollusks would be the same under the Proposed Project (not significant), impacts to the *Anodata spp*. would be less substantial under the Three Dam Removal Alternative than under the Proposed Project. However, impacts the Anodata spp. would still occur under the Three Dam Removal Alternative in the mainstem Klamath River (primarily downstream of Iron Gate Dam) as described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14), and based on predicted substantial short-term decrease in *Anodonta spp.* abundance of a year class, there would be a significant impact to the *Anodonta spp.* population under the Proposed Project in the short term.

However, the Three Dam Removal Alternative includes aquatic resource measure AR-7 (Freshwater Mussels) to reduce the short-term effects of sediment transport during dam removal on *Anodonta spp.*, as described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14). Under the Proposed Project this salvage and relocation plan would consider sites for translocation downstream from the Trinity River confluence (RM 43.4), and between J.C. Boyle Dam (RM 230.6) and Copco Reservoir (RM 209.0). These areas would have less impact from increased SSCs but would not be completely protected from short-term effects. The areas downstream of the Trinity River confluence do not currently support *Anodonta spp*. and are unlikely to in the future (Davis et al. 2013). However, under the Three Dam Removal Alternative *Anodonta spp*. could be salvaged from the reach downstream of Iron Gate Dam and relocated to J.C. Boyle Reservoir, which does support suitable *Anodonta spp*. habitat. Therefore, with aquatic resource measure AR-7, there would likely not be a substantial reduction in the abundance of *Anodonta spp.* species in the short term, and impacts would be not significant with for *Anodonta spp.* in the short term.

Significance

No significant impact for *M. falcata, G. angulate, or Anodonta spp.* in the short or long term

No significant impact for freshwater clams in the short or long term

4.6.4 Phytoplankton and Periphyton

4.6.4.1 Phytoplankton

Short-term mobilization of J.C. Boyle Reservoir sediment deposits would not occur under the Three Dam Removal Alternative (see Section 4.6.2.2 *Suspended Sediments*), thus there would be no short-term increase in sediment-associated nutrients downstream of J.C Boyle Dam (see Section 4.6.2.3 *Nutrients*). While there would be a short-term increase in sediment-associated nutrients between Copco No. 1 Reservoir and Iron Gate Dam in the Hydroelectric Reach, as well as in the Middle Klamath River, Lower Klamath River, and Klamath River Estuary during reservoir drawdown (see Section 4.6.2.3 *Nutrients*), minimal deposition of fine suspended sediments, including the associated nutrients, would occur in the river channel and the estuary (Stillwater Sciences 2008; USBR 2012). Thus, the short-term increase in nutrients would be limited to the time period when sediment deposits are being transported through the Klamath River. The drawdown of Copco No. 1 and Iron Gate reservoirs and release of these nutrients also would occur during winter months when the rates of phytoplankton growth and reproduction along with the rates of nutrient transformations by microbes (e.g., nitrification and denitrification) are relatively low, so the ability of phytoplankton to use sediment-associated nutrients mobilized during reservoir drawdown would be low (see Potential Impact 3.4-1). Sediment released during reservoir drawdown under the Three Dam Removal Alternative also would increase suspended sediment concentrations and water turbidity (see also Potential Impact 3.2-3), limiting light availability for phytoplankton photosynthesis and further reducing the potential for additional phytoplankton growth and reproduction. Under the Three Dam Removal Alternative, the sediment-associated nutrients would be less than under the Proposed Project since no J.C. Boyle sediment-associated nutrients would be released, but the overall impact would be the same in both the Three Dam Removal Alternative and the Proposed Project. The sediment-associated nutrients would not be likely to stimulate phytoplankton growth or reproduction that would lead to an increase spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton, so there would be no significant impact.

With respect to potential long-term impacts, J.C. Boyle Reservoir does not support low mixing conditions or thermal stratification that create optimal habitat for phytoplankton growth or reproduction under existing conditions due to its shallow depth (8.3 feet average depth) and short hydraulic residence time (approximately 1 day at average flows, Table 3.6-4) and it would not do so under the Three Dam Removal Alternative. Peaking power generation flows are released in the late afternoons and early evenings to meet high power demand, and J.C. Boyle Reservoir refills during the night when power demand is minimal. Daily fluctuations in the reservoir water level under existing operations increases mixing in the reservoir, making the reservoir slightly less suitable habitat for phytoplankton during the season of maximum phytoplankton and cyanobacteria (blue-green-algae) growth in the system. Ceasing peaking power generation flows would reduce daily reservoir water level fluctuations in J.C. Boyle Reservoir because the facility would no longer be operated to draw on reservoir storage to support daily peaks in hydropower production when there is not sufficient river flow for peak production (3,000 cfs), as occurs during the summer and fall low flow period under existing conditions. However, the residence time of J.C. Boyle Reservoir without peaking operations would still be short (i.e., on the order of one to three days), so leaving this dam in place and ceasing peaking flows would not change long-term phytoplankton growth or reproduction and thus it would not change the spatial extent, temporal duration, or concentration of nuisance and/or noxious phytoplankton blooms, including blue-green algae, to the degree that new or further impairment of designated beneficial uses would occur.

Copco No. 1 and Iron Gate reservoirs currently support growth conditions for toxin-producing nuisance phytoplankton species such as *Microcystis aeruginosa*, with these two reservoirs serving as the primary habitat for blue-green algae in the Hydroelectric Reach. Thus, the removal of Copco No. 1 and Iron Gate reservoirs under the Three Dam Removal Alternative would eliminate the main habitat toxin-producing nuisance phytoplankton and reduce the long-term spatial extent, temporal duration, and concentration of nuisance and/or noxious phytoplankton species relative to existing conditions, consistent with the Proposed Project. The elimination of Copco No. 1 and Iron Gate reservoirs would be beneficial in the Hydroelectric Reach downstream of Copco No. 1 Reservoir. Due its small size and low residence time (less than a day), Copco No. 2 Reservoir does not promote phytoplankton growth under existing conditions and its removal under the Three Dam Removal Alternative also would not affect the spatial extent, temporal duration, and concentration of nuisance and/or noxious phytoplankton species within the Hydroelectric Reach or downstream reaches.

Because seasonal phytoplankton blooms are primarily internally generated in Copco No. 1 and Iron Gate reservoirs, removal of these reservoirs under the Three Dam Removal Alternative would also decrease or eliminate the long-term downstream transport of nuisance and/or noxious phytoplankton species and their associated toxins from Copco No. 1 and Iron Gate reservoirs into the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment. The decrease or elimination of long-term downstream transport of phytoplankton cells from Copco No. 1 and Iron Gate reservoirs would also reduce the seasonal (i.e., summer and fall) downstream transport of nutrients contained in those phytoplankton cells that potentially promote seasonal increases in phytoplankton and/or periphyton growth in the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment.

In summary, relative to existing conditions, the potential impacts and impacts of the Three Dam Removal Alternative on phytoplankton would be the same as or similar to those described for the Proposed Project, as follows:

- There would be no short-term change in phytoplankton growth and reproduction from existing conditions in the Hydroelectric Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir due to mobilization of sediment-associated nutrients from J.C. Boyle Reservoir because this reservoir and its sediment deposits would remain in place (Potential Impact 3.4-1).
- While there would be short-term increases in sediment-associated nutrients downstream of Copco No. 1 Dam due to the release of sediments currently trapped behind the Copco No. 1 and Iron Gate dams, there would not be an increase in the spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton species, including blue-green algae, in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, and the Klamath River Estuary that results in new or further impairment of designated beneficial uses; therefore, there would be no significant impact in the short term (Potential Impact 3.4-1).
- There would be no significant impact in the long term from J.C. Boyle Dam remaining in place and ceasing peaking power generation flows on the spatial extent, temporal duration, transport, and/or concentration of nuisance and/or noxious phytoplankton species and concentrations of algal toxins because J.C. Boyle Reservoir would not support habitat that would promote phytoplankton blooms under the Three Dam Removal Alternative, similar to under existing conditions (Potential Impact 3.4-2).
- Long-term reduction in the spatial extent, temporal duration, transport, and/or concentration of nuisance and/or noxious phytoplankton species and concentrations of algal toxins due to elimination of Copco No. 1 and Iron Gate reservoir habitats would be beneficial for the Hydroelectric Reach, Middle and Lower Klamath River, and Klamath River Estuary (Potential Impact 3.4-2). There would be no significant impact for the Pacific Ocean nearshore environment (Potential Impact 3.4-2).

4.6.4.2 Periphyton

Short-term mobilization of J.C. Boyle Reservoir sediment deposits would not occur under the Three Dam Removal Alternative, thus there would be no short-term increase in sediment-associated nutrients downstream of J.C Boyle Dam. While there would be a short-term increase in sediment-associated nutrients between Copco No. 1 Reservoir and Iron Gate Dam in the Hydroelectric Reach, as well as in the Middle Klamath River, Lower Klamath River, and Klamath River Estuary during reservoir drawdown, minimal deposition of fine suspended sediments, including the associated nutrients, would occur in the river channel and the estuary (Stillwater Sciences 2008; USBR 2012). Thus, the short-term increase in nutrients would be limited to the time period when sediment deposits are being transported through the Klamath River. The drawdown of Copco No. 1 and Iron Gate reservoirs and release of these nutrients would occur during winter months when the rates of periphyton growth and reproduction along with the rates of nutrient transformations by microbes (e.g., nitrification and denitrification) are relatively low due to less light availability for photosynthesis and lower water temperatures. As a result, the ability of periphyton to use sediment-associated nutrients would be limited and there would not be an increase in periphyton growth or reproduction during this period, even though additional nutrients would be available due to the release of sediments trapped behind the Lower Klamath Project dams. Light limitation from high concentrations of suspended sediments in the water (Potential Impact 3.2-3) would also reduce any potential for nuisance levels of periphyton growth during reservoir drawdown. Additionally, high river flows during the winter drawdown period and late spring storm events would result in greater sediment movement and scouring, which would greatly limit, if not eliminate, the area of the streambed that periphyton can establish to grow during this period. Thus, the Three Dam Removal Alternative would not be likely to stimulate an increase in periphyton growth or reproduction and result in an increase in the spatial extent, temporal duration, or biomass of nuisance periphyton species that causes a new or further impairment of designated beneficial uses, similar to the Proposed Project.

Under the Three Dam Removal Alternative, J.C. Boyle Reservoir would remain in place and peaking power generation and release of recreation flows would cease from J.C. Boyle Dam, so there would be less artificial diel (24-hour) temperature variation during summer and early fall in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir similar to the Proposed Project (see also Potential Impact 3.2-1). J.C. Boyle retains relatively little nutrients under existing conditions (see Appendix C, Section C.3.1.1 *Hydroelectric Reach*), and therefore nutrient conditions in this reach would be the same under the Three Dam Removal Alternative as under existing conditions since there would be no change in nutrient interception or retention with J.C. Boyle Dam remaining in place. The less diel (24-hour) temperature variations and slight decrease in the maximum water temperature in this reach is not anticipated to affect periphyton colonization. Additionally, the generally high gradient and velocity in the J.C. Boyle Peaking Reach does not currently support excessive periphyton mats and it is not anticipated this reach would support excessive periphyton mats under lower flows once peaking and recreation flows cease. In the short term and long term, increases in periphyton biomass from elimination of peaking and recreation flows along with the change in water temperature in this reach are expected to be limited under the Three Dam Removal Alternative and any potential increase in periphyton would not result in new or further impairment of designated beneficial uses.

Further downstream in the Hydroelectric Reach, periphyton growth in low-gradient channel margin areas in the footprints of Copco No. 1 and Iron Gate reservoirs could increase on a seasonal basis following dam removal because removal of the reservoirs would provide additional low-gradient habitat suitable for periphyton assemblages. Dam removal construction and restoration activities in dam removal year 2 and additional sediment transport and scour during winter post-dam removal year 1 may inhibit some periphyton growth in the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, but, overall, periphyton would be expected to begin colonizing the newly created suitable habitat within the short term and would continue in the long term. Similar to the Proposed Project (Potential Impact 3.4-4), conservatively this would be a significant impact with respect to periphyton growth. The response of periphyton in the river is subject to many competing processes that could either accelerate or hinder periphyton growth and potential increases in nuisance periphyton (i.e., *Cladophora* sp.) extent, duration, and biomass. In the long term, improvements (i.e., reductions in biomass) are expected from several processes such as scour and in-stream retention processes, whereas improvements could be diminished by processes such as reduced nutrient retention from the reservoirs or climate change. While the growth of nuisance periphyton along channel margin areas is not expected to contribute algal toxins that would impair water quality, the degree to which designated beneficial uses would be impaired due to an increase in nuisance periphyton species (i.e., *Cladophora* sp.) in the newly formed low-gradient channel margin areas of the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam is not fully understood. The implications of potential changes in periphyton biomass and community composition on dissolved oxygen and the spread of fish disease under the Three Dam Removal Alternative would be similar to those described in Section 3.2.5.4 *Dissolved Oxygen* and Section 4.6.3.4 *Fish Disease and Parasites*, respectively, for the reach between Copco No. 1 Reservoir and Iron Gate Dam.

In summary, relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on periphyton would be the same as or similar to those described for the Proposed Project, as follows:

- There would be no significant impact in the short term from changes in periphyton growth compared to existing conditions due to mobilization of sediment-associated nutrients from J.C. Boyle Reservoir (Potential Impact 3.4-3) because this reservoir and its sediment deposits would remain in place.
- Mobilization of sediment-associated nutrients from Copco No. 1 and Iron Gate reservoirs would occur under the Three Dam Removal Alternative, but usage of these nutrients would be limited due to lower light levels reducing photosynthesis for periphyton growth and higher flows scouring periphyton from the streambed during winter and early spring. Thus, there would not be an increase in the spatial extent, temporal duration, or biomass of nuisance periphyton species in the Hydroelectric Reach downstream of Copco No. 1, the Middle and Lower Klamath River, or the Klamath River Estuary that would result in a new or further impairment of designated beneficial uses (Potential Impact 3.4-3), and there would be no significant impact.
- There would be no short-term or long-term increase in nuisance periphyton growth that results in new or further impairment of designated beneficial uses in the Hydroelectric Reach from J.C. Boyle Dam to Copco No. 1 Reservoir, including the Oregon-California state line, due to increased nutrients or ceasing of peaking flows at J.C. Boyle (Potential Impact 3.4-4), so there would be no significant impact.
- There could be a short-term and/or long-term increase in nuisance periphyton growth that would result in new or further impairment of designated beneficial uses in the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam due to an increase in nutrients and available low-gradient channel margin habitat from conversion of the Copco No. 1 and Iron Gate reservoir areas to a free-flowing river (Potential Impact 3.4-4) and if this increase were to occur, it would be a significant and unavoidable impact.
- There would be no long-term increase in biomass of nuisance periphyton that would result in new or further impairment of designated beneficial uses in the Middle Klamath River, Lower Klamath River, and Klamath River Estuary due to increased nutrient availability from upstream dam removal under the Three Dam Removal Alternative similar to the Proposed Project (Potential Impact 3.4-5), so there would be no significant impact.

4.6.5 Terrestrial Resources

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes construction of a new fish ladder at J.C. Boyle Dam (and removal of the existing one within a similar footprint to the existing ladder). While there would potentially be less construction activities resulting in noise or habitat removal under this alternative than under the Proposed Project, the relative decrease in construction activities under the Three Dam Removal Alternative would not change the level of impacts to terrestrial resources in California since J.C. Boyle is located in Oregon. Thus, potential impacts on sensitive habitats (wetlands and riparian habitat), rare natural communities, culturally significant species, special-status species, wildlife corridors and habitat connectivity within the Primary Area of Analysis for terrestrial resources would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impacts 3.5-1 through 3.5-31).

4.6.6 Flood Hydrology

For the reasons discussed below, potential impacts on flood hydrology resources in California would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impacts 3.6-1 through 3.6-6). J.C. Boyle Reservoir has a relatively small storage capacity (2,267 acre-feet total storage; 1,724 acre-feet active storage; see Table 3.6-4) and is not operated by PacifiCorp as a flood control reservoir. Thus, leaving J.C. Boyle Dam in place under the Three Dam Removal Alternative would not affect the FEMA 100-year floodplain nor risks related to flooding during reservoir drawdown downstream from the Oregon-California state line relative to the Proposed Project. Ceasing peaking power generation or release of flow for recreation at J.C. Boyle Dam would reduce daily reservoir level variability, as well as flow variability in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir, relative to existing conditions. However, because the reservoir active storage is relatively small, these changes would not affect flood hydrology. Therefore, the flood hydrology impacts of the Three Dam Removal Alternative would be the same as those described for the Proposed Project and there would be no significant impacts for Potential Impacts 3.6-1, 3.6-2, and 3.6-4 through 3.6-6. There would be significant and unavoidable impacts related to exposing structure to a substantial risk of damage due to flooding downstream of the location of Iron Gate Dam (Potential Impact 3.6-3).

4.6.7 Groundwater

would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impacts 3.7-1 and 3.7-2). The Klamath River within the Hydroelectric reach is a gaining reach (i.e., regional groundwater discharges to the river). Groundwater contributions from the Lower Klamath Project reservoirs to surrounding aquifers likely only extends to the immediate vicinity of the reservoirs (i.e., less than approximately 2 miles) (USBR 2012). J.C. Boyle Reservoir is located more than 20 river miles upstream of the other Lower Klamath Project reservoirs, and thus leaving it in place under the Three Dam Removal Alternative would not influence groundwater wells located in the vicinity of Copco No. 1 and Iron Gate reservoirs. Removal of Copco No. 1 and Iron Gate reservoirs under the Three Dam Removal Alternative would result in the same effects on groundwater as described for the

Proposed Project (Section 3.7 *Groundwater*). For the reasons described in Potential Impacts 3.7-1 and 3.7-2, and there would be no significant impacts.

4.6.8 Water Supply/Water Rights

For the reasons discussed below, the water supply and water rights impacts of the Three Dam Removal Alternative would be the same as those analyzed under the Proposed Project (Potential Impacts 3.8-1 through 3.8-5). As discussed in Section 3.8 *Water Supply/Water Rights*, under existing conditions none of the Lower Klamath Project facilities are water supply facilities. Thus, the same set of influences that currently dictate water availability in California would continue to do so regardless of whether J.C. Boyle Dam is removed (as under the Proposed Project) or remains (as under the Three Dam Removal Alternative).

The Lower Klamath Project reservoir that would remain under the Three Dam Removal Alternative, J.C. Boyle, has a relatively small storage capacity (2,267 acre-feet total storage; 1,724 acre-feet active storage; see Table 3.6-4) and, like other Lower Klamath Project facilities, is not a water supply facility for consumptive use in Oregon or California. Ceasing peaking power generation and recreation flow releases at J.C. Boyle Dam would reduce daily reservoir level variability, as well as flow variability downstream from J.C. Boyle Dam, relative to existing conditions. Minimum flows in California under the Three Dam Removal Alternative would be the same as those analyzed under the Proposed Project because minimum instream flows would still be mandated by BiOp requirements. As under the Proposed Project, reducing riverine flow fluctuation in the Hydroelectric Reach and removing the California reservoirs would not reduce the amount of water available or impact diversion facilities for the three diversions identified from the Oregon-California state line to Copco No. 1 Reservoir. Thus, Potential Impacts 3.8-1, 3.8-2, and 3.8-5 under the Proposed Project would be the same under the Three Dam Removal Alternative, and there would be no significant impacts.

Short-term mobilization of J.C. Boyle Reservoir sediment deposits would not occur under the Three Dam Removal Alternative and none of the associated 1,190,000 cubic yards of deposits (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches, although little to no sediment deposition would be expected in the reach between J.C. Boyle and Copco No. 1 (USBR 2012). However, mobilization of reservoir sediment deposits in the much larger Copco No. 1 and Iron Gate reservoirs[229] would still occur such that release of stored sediment during reservoir drawdown could still impact water intake pumps downstream from Iron Gate Dam (Potential Impact 3.8-3). Implementation of Mitigation Measure WSWR-1 would be required to result in no significant impact.

The City of Yreka's municipal water supply pipeline would still need to be relocated following drawdown of Iron Gate Reservoir, and there would still be potential for disruption to the City's water supply. Implementation of Mitigation Measure WSWR-2 would reduce this potential impact to less than significant.

[229] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

4.6.9 Air Quality

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. Although this would be less construction than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to air quality in California. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Like the Proposed Project, due to the potential for the emissions generated from construction activity in Oregon to have air quality impacts in Siskiyou County, California, the emissions from construction activity in Oregon are conservatively included in the estimate of total emissions due to construction activity under this alternative. In California, construction activities at Copco No. 1, Copco No. 2, and Iron Gate dams would occur under the Three Dam Removal Alternative in the same manner as under the Proposed Project. Thus, overall the detailed discussion of impacts to air quality provided in the Proposed Project also applies to this alternative (see also Appendix N). Note that the magnitude of estimated emissions due to J.C. Boyle Dam and Powerhouse deconstruction is relatively low compared with the other three dam complexes, such that reducing this estimate for a lesser degree of construction under the Three Dam Removal Alternative would not change the expectation that emissions would exceed the Siskiyou County Air Pollution Control District emissions thresholds (see Table 3.9-5). Thus, potential air quality impacts due to construction activities under the Three Dam Removal Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.9-1 through 3.9-5). Like the Proposed Project, construction activities occurring under the Three Dam Removal Alternative would exceed the Siskiyou County Air Pollution Control District emissions thresholds for NO_x, PM_{10}, and $PM_{2.5}$ and would result in a significant and unavoidable impact.

4.6.10 Greenhouse Gas Emissions

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. Although this would be less construction than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts due to GHG emissions in California. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. As with the Proposed Project, due to the cumulative nature of GHG emissions, the emissions from construction activity in Oregon are conservatively included in the estimate of total emissions due to construction activity under this alternative. In California, construction activities at Copco No. 1, Copco No. 2, and Iron Gate dams would still occur and this, combined with lesser degree of construction activities in Oregon, means that the detailed discussion of impacts to greenhouse gases provided in the Proposed Project (Potential Impact 3.10-1) also applies to this alternative, albeit with slightly lower overall GHG emissions. Leaving J.C. Boyle Dam in place and lowering overall construction-related emissions relative to the Proposed Project would not change the potential for a conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases (Potential Impact 3.10-2). Overall, Three Dam Removal Alternative would result in no significant impacts due to greenhouse gas emissions.

4.6.11 Geology, Soils, and Mineral Resources

For the reasons discussed below, the Three Dam Removal Alternative would have similar effects on geology, soils, and mineral resources in California as would the Proposed Project (Section 3.11 *Geology, Soils, and Mineral Resources*), with minor differences discussed at the end of this section. Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes construction of a new fish ladder at J.C. Boyle Dam (and removal of the existing one within a similar footprint to the existing ladder). If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. While there would potentially be less construction activities resulting in short-term soil disturbance under this alternative than under the Proposed Project, the relative decrease in construction activities under the Three Dam Removal Alternative would not change the potential for impacts due to geologic hazards, short-term soil disturbance, hillslope instability, earthen dam embankment instability, or loss of mineral resources in California since J.C. Boyle is located in Oregon.

In California, potential impacts under the Three Dam Removal Alternative would be due to removal and reservoir drawdown activities at Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities in California. Thus, there would be no significant impacts due to potential for changes to geologic hazards, short-term soil disturbance, earthen dam embankment instability, and mineral resource availability under the Three Dam Removal Alternative for the reasons described for the Proposed Project (Potential Impacts 3.11-1, 3.11-2, 3.11-4 and 3.11-8).

For the reasons described for the Proposed Project, Implementation of Mitigation Measure GEO-1 would be necessary to reduce the potential impacts resulting from slope failure in reservoir rim areas at Copco No. 1 Reservoir (see Potential Impact 3.11-3). With implementation of Mitigation Measure GEO-1, there would be no significant impacts due to the potential for hillslope instability at Copco No. 1 Reservoir during drawdown and the year following drawdown.

Under the Three Dam Removal Alternative, J.C. Boyle Dam would remain in place and none of the associated 1,190,000 cubic yards of reservoir sediment deposits (eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches. The latter would reduce associated short-term erosion and sediment delivery impacts (i.e., sedimentation and bank erosion downstream of Iron Gate Reservoir) that would occur under the Proposed Project, given the relatively smaller volume of sediments in J.C. Boyle Reservoir compared with Copco No. 1 and Iron Gate reservoirs. However, the effect would be relatively small since mobilization of reservoir sediment deposits in the much larger Copco No. 1 and Iron Gate reservoirs[230] would still occur. Therefore, potential

[230] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1

short-term erosion and sediment delivery impacts under the Three Dam Removal Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.11-5 through 3.11-7) and there would be no significant impacts, with the exception of the Middle Klamath River between Iron Gate Dam and Cottonwood Creek where there would be a significant and unavoidable impact (see Potential Impact 3.11-5). In the long term, J.C. Boyle Reservoir would continue accumulating sediment at approximately the rate that it does under existing conditions, which is generally low (see Table 3.11-6).

4.6.12 Historical Resources and Tribal Cultural Resources

Leaving the J.C. Boyle Dam and associated facilities in place would reduce construction activities related to dam removal relative to the Proposed Project; however, it would not decrease the degree of construction activities or the associated impacts to historical and tribal cultural resources in California since J.C. Boyle is located in Oregon. Unlike under the Proposed Project, reservoir drawdown associated with the removal of J.C. Boyle Dam would not occur under the Three Dam Removal Alternative. However, as discussed in Potential Impact 3.12-3, drawdown releases from J.C. Boyle Dam under the Proposed Project would not cause flooding of the river between the dam and Copco No. 1 Reservoir and would not result in short-term erosion or flood disturbance to the numerous prehistoric archaeological riverside sites with habitation debris, house pits and rock features and cemeteries; as well as ethnographic places and other features of the cultural landscape that have been identified as TCRs along this reach of the Klamath River (PacifiCorp 2004, Daniels 2006). Therefore, leaving J.C. Boyle Dam in place under the Three Dam Removal Alternative would have no bearing on the potential for impacts to known or unknown historical and/or tribal cultural resources within this reach and, like the Proposed Project, there would be no significant impact. The potential for flood disturbance further downstream along the Klamath River would not be different under this alternative from that described for the Proposed Project (Potential Impact 3.12-3) since Copco No. 1, Copco No. 2, and Iron Gate dams would still be removed.

As Copco No. 1, Copco No. 2, and Iron Gate dams would be removed under this alternative as described for the Proposed Project, other potential impacts to tribal cultural resources (Potential Impacts 3.12-1, 3.12-2, 3.12-4 through 3.12-8) and the built environment and historic-period archaeological resources (Potential Impacts 3.12-11 through 3.12-16) and would be the same as those described for the Proposed Project. Implementation of Mitigation Measures TCR-1 through TCR-8 would be required to reduce impacts to tribal cultural resources, but the impacts would remain significant and unavoidable.

There would be approximately 18.5 miles of additional riverine habitat that would become available for salmonids under this alternative (not including 3.5 miles of riverine habitat that would remain inundated by J.C. Boyle Reservoir). The additional habitat, combined with a reduced incidence of fish disease and parasites in the Klamath River under this alternative (see Section 4.6.3.4 *Fish Disease and Parasites*), would improve conditions for the Klamath Cultural Riverscape related to fisheries (Potential Impact 3.12-9) relative to existing conditions. This would be a beneficial effect. Reductions in blue-green algae concentrations under this alternative (see Section 4.6.2.6 *Chlorophyll-a*

Reservoir that would subsequently be released downstream once drawdown begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

and Algal Toxins) would support Cultural Use of Klamath River waters without risk of adverse health effects, which would improve tribal members' access to the river above levels occurring under existing conditions (Potential Impact 3.12-10) and would be a beneficial effect.

4.6.13 Paleontologic Resources

For the reasons described under Proposed Project, there could be instances of bank erosion and slope failures in the Middle Klamath River due to changes in river discharge should the Copco No. 1, Copco No. 2, and Iron Gate dams be removed (Potential Impact 3.13-1). However, the magnitude of this bank erosion would not be substantial compared to existing conditions and there would be a low likelihood that downcutting or erosion of the Hornbrook Formation located downstream of Iron Gate Dam would occur to a greater degree than existing conditions. Because of its small size (2,267 acre-feet total storage; see Table 3.6-4) and because it is not operated by PacifiCorp as a flood control reservoir, retaining J.C. Boyle Reservoir under this alternative would not affect the likelihood of downcutting or erosion relative to existing conditions or the Proposed Project. For these reasons, and given the formation's Low Paleontologic Potential (Potential Impact 3.13-1), there would be no significant impact to paleontologic resources under the Three Dam Removal Alternative.

4.6.14 Land Use and Planning

Under the Three Dam Removal Alternative, the impacts on land use and planning in California would be the same as those described for the Proposed Project in Section 3.14.5 *[Land use and Planning] Potential Impacts and Mitigation*. Because long-term land use under this alternative is currently unknown, this alternative does not assess the potential impacts of long-term use of the lands currently submerged under Iron Gate and Copco No. 1 reservoirs as that would require speculation. The California dam removal actions would occur in the same manner under both the Three Dam Removal Alternative and under the Proposed Project. Maintaining or removing J.C. Boyle Dam 20 miles upstream in Oregon would not have an impact on California land use or planning.

4.6.15 Agriculture and Forestry Resources

The potential for impacts on agriculture and forestry resources in California under the Three Dam Removal Alternative would be the same as described for the Proposed Project because retaining J.C. Boyle Dam would not change or result in the conversion of any California land use relating to agriculture or forestry. In addition, the issues relating to agricultural water in the Lower Klamath Project area would be the same regardless of whether J.C. Boyle Dam remains in place or is removed. Therefore, under the Three Dam Removal Alternative, potential impacts on agriculture and forestry resources would be the same as those of the Proposed Project and there would be no significant impacts (Potential Impacts 3.15-1 through 3.15-3).

4.6.16 Population and Housing

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Although there would be less construction for fish passage than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated California impacts to population and housing that are described for the Proposed Project (Potential Impacts 3.16-1 and 3.16-2). Like the Proposed Project, the Three Dam Removal Alternative would not result in a substantial influx of population (Potential Impact 3.16-1), nor would there be a need to displace existing residents or build replacement housing elsewhere (Potential Impact 3.16-2), and there would be no significant population and housing impacts.

4.6.17 Public Services

Overall, under the Three Dam Removal Alternative, potential impacts on public services in California would be the same as those described for the Proposed Project. The California dam removal actions would occur in the same manner under both the Three Dam Removal Alternative and under the Proposed Project. Thus, for reasons described in Section 3.17.5 *[Public Services] Potential Impacts and Mitigation*, impacts and associated mitigation measures from increased public service response times for emergency fire, police, and medical services due to construction and demolition activities, elimination of a long-term water source for wildfire services substantially increasing the response time for suppressing wildfires, and potential effects on schools services and facilities would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impacts 3.5-1 through 3.5-3).

4.6.18 Utilities and Service Systems

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Although there would be less construction for fish passage than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to public services in California since J.C. Boyle is in Oregon. Thus, potential construction-related impacts to utilities and service systems would be the same as described for the Proposed Project (Potential Impacts 3.18-1 through 3.18-4). There would be no significant impacts on utilities and service systems related to this degree of construction for the Proposed Project, and construction is the only part of the proposed activities that merits analysis for potential impacts on utilities and service systems. Construction-related activity in California would still require the need for onsite wastewater treatment, stormwater drainage, and/or solid waste disposal facilities at the same level as the Proposed Project (Potential Impacts 3.18-1 through 3.18-4) and would result in no significant impacts.

4.6.19 Aesthetics

Under the Three Dam Removal Alternative, the aesthetic impacts would be the same as described for the Proposed Project (Section 3.19). The California dam removal actions would occur in the same manner under both the Three Dam Removal Alternative and the Proposed Project. Although the level of overall construction activities due to dam deconstruction in California and construction of upstream and downstream fish passage in Oregon under the Three Dam Removal Alternative would be less than that of the Proposed Project, construction-related activities at J.C. Boyle Dam, which is located 20 miles upstream of the Oregon-California state line, would not affect California aesthetics.

For the reasons described in Section 3.19.5 *[Aesthetics] Potential Impacts and Mitigation*, under the Three Dam Removal Alternative, short-term and long-term impacts on aesthetic resources in California, including a loss of open water and lake vistas in favor of more natural river, canyon, and valley vistas (Potential Impact 3.19-1) and changes in river flows, channel morphology, and visual water quality (Potential Impacts 3.19-2 and 3.19-3) would be the same as those of the Proposed Project, since Copco No. 1, Copco No. 2, and Iron Gate reservoirs would be removed, and there would be no significant impacts. Visual changes resulting from drawdown of Copco No.1, Copco No. 2 and Iron Gate reservoirs would be significant and unavoidable in the short term and would have no significant impact in the long term (Potential Impact 3.19-4). Visual changes due to removal of the California dams and facilities and improvements to or construction of new infrastructure (Potential Impact 3.19-5), and construction activities (Potential Impact 3.19-6) would also be the same as those of the Proposed Project since the manner of dam deconstruction would be the same under the Three Dam Removal Alternative. Impacts from construction lighting would still be significant and unavoidable as under the Proposed Project (Potential Impact 3.19-7).

4.6.20 Recreation

Under the Three Dam Removal Alternative, short-term construction-related activities would occur at Copco No. 1, Copco No. 2 and Iron Gate dams and associated facilities and would be lower than those described for the Proposed Project (Potential Impact 3.20-1). For the reasons described in Potential Impact 3.20-1, there would be no significant impact on recreation from the Three Dam Removal Alternative. Recreational facilities associated with Copco No. 1 and Iron Gate reservoirs would still be subject to closure and reservoir-related recreation would still increase the use of other regional recreational facilities and/or would be replaced with river-related recreation; however as with the Proposed Project there would be no significant impacts (Potential Impacts 3.20-2 and 3.20-3). Under the Three Dam Removal Alternative, all portions of the existing recreational facilities at J.C. Boyle Reservoir (Pioneer Park, Topsy Campground, Spring Island River Access) would remain in place under this alternative, offering more regional boating and fishing recreational opportunities relative to the Proposed Project. Elimination of peaking operations and higher baseflows under this alternative may increase the appeal of J.C. Boyle Reservoir recreational sites due to elimination of regular reservoir water level fluctuations and increased low flows in the Hydroelectric Reach.

While the Three Dam Removal Alternative would not remove J.C. Boyle Reservoir, it also would increase minimum flows in the Bypass Reach and would not include peaking power generation or release of flows for recreation at J.C. Boyle Dam. Since there would be no recreational flows in the Hydroelectric Reach under this alternative, and flows in the Hydroelectric Reach would be similar to those under the Proposed Project, the loss of whitewater boating opportunities in the Hell's Corner Reach (within the upper portion of the Hydroelectric Reach) would be the same as the Proposed Project

(Potential Impact 3.20-5) and would be significant and unavoidable. There would be no significant impact in the Middle and Lower Klamath River.

Under the Three Dam Removal Alternative, removal of Copco No. 1, Copco No. 2 and Iron Gate dams and construction of upstream and downstream fish passage at J.C. Boyle Dam would beneficially affect recreational fishing of anadromous fish (Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout) throughout the Hydroelectric Reach in California, as described for the Proposed Project (Potential Impact 3.20-6). The primary difference under the Three Dam Removal Alternative is that approximately 3.5 miles of aquatic habitat within J.C. Boyle Reservoir would remain lentic rather than reverting to the riverine conditions described for the Proposed Project; however, this would occur in Oregon and so would not affect California recreational fishing.

The Three Dam Removal Alternative would result in the same impacts to river-based recreational facilities in the Middle Klamath River and Lower Klamath River as the Proposed Project (Potential Impact 3.20-6). Water quality improvements would be beneficial for the Hydroelectric Reach, the Middle Klamath River downstream of Humbug Creek (RM 174.3), and the Lower Klamath River. With respect to potential flooding impacts to existing river-based recreational facilities, maintaining J.C. Boyle Reservoir would not affect flood hydrology, relative to Proposed Project or to existing conditions, in the Hydroelectric Reach or further downstream Middle Klamath River and Lower Klamath River (see also Section 4.6.6 *Flood Hydrology*). As under the Proposed Project, there would be little to no change to the 100-year floodplain extent in the Klamath River and Lower Klamath River, with the exception of the reach along the Middle Klamath River from Iron Gate Dam (RM 193.1) to the confluence with Humbug Creek (RM 174.0), where the 100-year floodplain extent would change slightly due to removal of the California Lower Klamath Project dams. However, the slightly increased potential for flooding in this reach would not represent a change or loss of a rare or unique river-based recreational facility affecting a large area or substantial number of people and therefore impacts to recreation under the Three Dam Removal Alternative would be the same as those described for the Proposed Project (Potential Impact 3.20-6) and would be less than significant.

4.6.21 Hazards and Hazardous Materials

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Although there would be less construction for fish passage than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts due to hazards and hazardous materials since J.C. Boyle is in Oregon. Construction activities in Oregon under this alternative would not change the hazards and hazardous materials analysis for California because the transport, use, and disposal of general construction waste materials (e.g., concrete, rebar, building waste, power lines) associated with J.C. Boyle Dam removal and fish passage construction, as well as construction-related activities that could result in the accidental release of hazardous materials to the environment, would occur in Oregon. Potential construction-related impacts would be the same as those of the Proposed Project (Potential Impacts 3.21-1, 3.21-2, 3.21-4, and 3.21-7) and would be significant. Implementation of Mitigation Measure HZ-1 would result in no significant impacts for these construction-related impacts. With respect to removal of the Lower Klamath Project reservoirs as a readily available source of water for helicopter fire suppression crews fighting local fires, the two largest reservoirs (Copco No. 1 and Iron Gate) would still be removed under this alternative, which would substantially increase the public's risk of loss, injury or death associated with wildfires as described for the Proposed Project (Potential Impact 3.21-8). J.C. Boyle Reservoir would remain in place and would continue to serve as a relatively accessible water surface for helicopter fire suppression crews compared to the mainstem Klamath River. However, because J.C. Boyle Reservoir is approximately 20 river miles upstream of Copco No. 1 Reservoir and has a relatively small surface area (approximately 350 acres versus 942 acres [Iron Gate Reservoir] and 972 acres [Copco No. 1 Reservoir], see also Table 2.3-1), response and travel times between water fills would still be increased over existing conditions and the Proposed Project for helicopter crews to fly to J.C. Boyle Reservoir for water pick up. Thus, the Three Dam Removal Alternative would result in a substantial increased public risk of loss, injury, or death involving wildland fires due to increased response and travel times relative to existing conditions and would be a significant impact.

4.6.22 Transportation and Traffic

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Although there would be less construction for fish passage than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to traffic and transportation since J.C. Boyle is in Oregon. Note that J.C. Boyle Dam-associated vehicle trips are included in the analysis of the Proposed Project as some of the construction-related traffic flow may use roads in California (e.g., I-5 to OR 66). As described in Section 3.22.5 *[Transportation and Traffic] Potential Impacts and Mitigation*, the Proposed Project would result in significant and unavoidable short-term impacts to traffic flow, road safety, road conditions, emergency access, public transit, and non-motorized transportation, unless and until KRRC reaches enforceable 'good citizen' agreements that are finalized and implemented through the FERC process and that include proposed items for the final TMP and Emergency Response Plan (Appendix B: *Definite Plan − Appendices O1 through O4*), as well as the additional components included in Recommended Measure TR-1 (Potential Impacts 3.22-1 through 3.22-5). As described for the Proposed Project, the Lower Klamath Project dams are not located within two miles of an airport nor would their removal result in a change in air traffic patterns that would result in a substantial safety risks, regardless of whether J.C. Boyle Dam remains place, and there would be no significant impact (Potential Impact 3.22-6).

4.6.23 Noise

The level of overall construction activities due to dam deconstruction in California and construction of upstream and downstream fish passage in Oregon under the Three Dam Removal Alternative would be the same as those described for the Proposed Project. Whether J.C. Boyle Dam remains or is removed would not affect noise impacts within the Proposed Project Area of Analysis due to J.C. Boyle Dam's location in Oregon, approximately 20 miles upstream of the Oregon-California state line. For the reasons described in Section 3.23.5 *[Noise] Potential Impacts and Mitigation Measures*, removal of Copco No. 1, Copco No. 2, and Iron Gate dams would result in noise and vibration that will affect sensitive receptors and exceed Siskiyou County General Plan standards under this alternative. Significant and unavoidable adverse environmental impacts would result from: construction equipment exceeding maximum allowable noise levels (Potential Impact 3.23-1); noise disturbance to residents from construction-generated noise at Copco No. 1 and Iron Gate dams (Potential Impacts 3.23-2 and 3.23-4), reservoir restoration at Copco No.1 and Iron Gate dams (Potential Impact 3.23-5); and vibration disturbance from blasting activities at Copco No. 1, Copco No. 2, and Iron Gate dams (Potential Impact 3.23-6). Other noise and vibration generation from the Three Dam Removal Alternative would not have a significant adverse impact (Section 3.23-5 *[Noise] Potential Impacts and Mitigation*).

4.7 No Hatchery Alternative

4.7.1 Introduction

4.7.1.1 Alternative Description

The No Hatchery Alternative is the same as the Proposed Project except that operations at the Iron Gate Hatchery would cease at the time of dam removal and would not continue for eight years following dam removal, and the Fall Creek Hatchery would not reopen with upgraded facilities. Under this alternative, all hatchery production of salmonids would be discontinued after hatchery releases occur in the fall of dam removal year 1 and the production goals for the Proposed Project as identified in Section 2.7.6 *Hatchery Operations* would not occur.

Post-dam removal adult fall-run Chinook salmon could continue to return to the former location of the hatchery through post-dam removal year 2 (age 4 returning adults), and post-dam removal adult coho salmon could continue to return potentially through post-dam removal year 1 (age 3 adults) (Table 4.7-1).

Table 4.7-1. Natural (N) and Hatchery (H) smolts and adult returns in Klamath River under the No Hatchery Alternative.

Species		Dam Removal Year		Post-dam Removal Year			
		1[a]	2[b]	1	2	3	4
Chinook salmon	Produced	N and final H smolts (age 0 in spring and age 1 in fall)	N smolts	N smolts from new habitat	N smolts	N smolts	N smolts
	Returning	N and H adults (age 3–4) downstream of Iron Gate Dam	N and H adults access new habitat	N and H adults	N and last H adults (age 4, progeny of post-dam removal year 1 outmigration)	N adults (age 3) from new habitat	N adults
Coho salmon	Produced	N and final H smolts (age 1)	N smolts	N smolts	N smolts from new habitat	N smolts	N smolts
	Returning	N and H adults (age 3) downstream of Iron Gate Dam	N and H adults access new habitat	N and last H adults (age 3, progeny of post-dam removal year 1 outmigration)	N adults	N adults (age 3) from new habitat	N adults

[a] Final year of hatchery releases occurs in dam removal year 1. Early drawdown of Copco No. 1 begins in dam removal year 1.
[b] Drawdown of all reservoirs occurs and dams are removed in dam removal year 2 (see Table 2.8-1).
H hatchery releases or progeny
N progeny of natural spawning (natural-origin)

Under the No Hatchery Alternative, construction activities would include all those identified under the Proposed Project, except that Iron Gate Hatchery facilities would be completely removed, instead of partially removed and redeveloped as under the Proposed Project (Section 2.7.1.4 *Iron Gate Dam and Powerhouse*). The fish trapping and holding facilities at the toe of Iron Gate Dam and the cold-water supply for the hatchery would be removed, consistent with the Proposed Project, but they would not be relocated. In order to make a conservative assumption about the greatest potential impact, this alternative assumes that all Iron Gate Hatchery facilities would be demolished, rather than re-purposed or decommissioned in place. Additional deconstruction activities at Iron Gate Hatchery under this alternative would therefore include removal of all weirs, traps, additional holding pools, raceways, tanks, buildings, and other infrastructure (see also Figure 2.3-4 and Section 2.7.1.4 *Iron Gate Dam and Powerhouse*). Iron Gate Hatchery facilities would be removed as part of dam deconstruction activities starting January 1 of dam removal year 2. Under the No Hatchery Alternative, water diversion from Bogus Creek to operate the Iron Gate Hatchery would not be needed, so the diversion for the hatchery water supply would not be constructed near the confluence of Bogus Creek and the Klamath River (Section 2.7.6 *Hatchery Operations*).

Under the No Hatchery Alternative, the Fall Creek Hatchery would not reopen with upgraded facilities (e.g., renovated raceways, upgraded plumbing) for raising coho salmon and Chinook salmon. Construction of the settling pond would not be needed on Parcel B lands downstream of the Fall Creek Hatchery. Water diversion from the PacifiCorp Fall Creek powerhouse return canal downstream of the City of Yreka's diversion facility at Fall Creek Dam A would not be needed. As Fall Creek Hatchery is part of PacifiCorp's Klamath Hydroelectric Project No. 2082, the existing Fall Creek Hatchery facilities are subject to the terms of any new FERC action for Project No. 2082. Accordingly, this alternative analysis assumes the status quo, i.e., that the Fall Creek Hatchery facilities would not be demolished or re-purposed.

4.7.1.2 Alternative Analysis Approach

The potential impacts of the No Hatchery Alternative are analyzed in comparison to existing conditions, with reference to impact analyses conducted for the Proposed Project, where appropriate. Unless otherwise indicated, the significance criteria, area of analysis, environmental setting, and impact analysis approach, including consideration of existing local policies, for all environmental resource areas under the No Hatchery Alternative are the same as those described for the Proposed Project (see Section 3.1 *Introduction* and individual resource area subsections in Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures*). The potential impacts for each environmental resource area are analyzed both in the short term and the long term, and unless otherwise indicated, use the same definitions of short term and long term as described for each resource area analyzed for the Proposed Project.

4.7.2 Water Quality

With the exception of potential water quality effects related to hatchery operations, the No Hatchery Alternative would have the same potential short-term and long-term impacts on water temperature, suspended sediments, nutrients, dissolved oxygen, pH, chlorophyll-*a*, algal toxins, and inorganic and organic contaminants relative to existing conditions as those described for the Proposed Project (Potential Impacts 3.2-1 through

3.2-18). Potential short-term impacts on water quality would be the same as those described for the Proposed Project because full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and related short-term impacts to water quality as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades that are included under the Proposed Project.

Under this alternative, there would be no discharges from Iron Gate Hatchery to the Middle Klamath River. While these hatchery discharges would be eliminated under this alternative, hatchery discharges under existing conditions have a less than significant impact on water quality, including water temperature, suspended material, nutrients, biochemical oxygen demand, and inorganic and organic contaminants (i.e., water treatment chemicals) based on an evaluation of the water quality impacts of California Department of Fish and Wildlife hatcheries, including Iron Gate Hatchery (ICF 2010) (for more detail see Potential Impact 3.2-17). There would be no changes to water quality in Fall Creek or the Klamath River under this alternative relative to existing conditions since Fall Creek Hatchery production has been zero since 2003 and it would remain zero under this alternative. Potential impacts to water quality in Fall Creek and the Klamath River under the Proposed Project (see Potential Impact 3.2-17) would not occur under this alternative since the Fall Creek Hatchery would not be reopened, fish production and associated water quality changes would not occur, and there would be no upgrades to Fall Creek Hatchery facilities to accommodate the fish production specified under the Proposed Project.

Overall, eliminating the Iron Gate Hatchery effluent discharges would reduce potential less-than-significant variations in water quality due to hatchery discharges compared to existing conditions or the lower fish production conditions under the Proposed Project, thus there would be no significant impact on water quality due to ceasing Iron Gate Hatchery operations under the No Hatchery Alternative. Additionally, there would be no change in water quality under this alternative compared to existing conditions due to Fall Creek Hatchery fish production continuing to be zero and potential impacts to water quality due to increases in fish production at Fall Creek Hatchery under the Proposed Project would be eliminated, thus there would be no significant impact on water quality due to Fall Creek Hatchery remaining closed under the No Hatchery Alternative.

4.7.3 Aquatic Resources

Potential impacts to most aquatic ecological attributes (e.g., suspended sediment, bedload, water quality, algal toxins, aquatic habitat, and instream flows) under the No Hatchery Alternative would be the same as impacts under the Proposed Project, described in Section 3.3.5 *[Aquatic Resources] Potential Impacts and Mitigation,* except that impacts to aquatic ecological attributes related to incidence of fish disease and resource competition would be different under the No Hatchery Alternative, as compared with those of the Proposed Project.

The current infectious nidus (i.e., the river reach exhibiting the highest infectivity) for salmonid smolts for *C. shasta* and *P. minibicornis* appears to be the result of the synergistic effect of high spore input from heavily infected spawned adult salmon that congregate downstream from Iron Gate Dam and Iron Gate Hatchery, and the proximity of congregating salmonids to dense populations of polychaetes (Bartholomew et al. 2007). Juveniles released from Iron Gate Hatchery may also contribute to the infectious nidus, as hatchery released juvenile fish that become infected and experience mortality further downstream in the Klamath River may become another source of myxospores threatening aquatic resources in the Middle and Lower Klamath River (Som et al. 2016c).

Discontinuing hatchery operations would eliminate the congregation of returning hatchery adults to the reach immediately downstream of Iron Gate Dam beginning in post-dam removal year 3 (Table 4.6-1), because dam removal would increase the likelihood that adults would disperse further upstream beginning in post-dam removal year 1 (note that the effect of dam removal on fish disease and parasites is described in more detail in Section 3.3.5 *[Aquatic Resources] Potential Impacts and Mitigation*).

In addition, beginning in dam removal year 2, hatchery juveniles would no longer be released during the natural smolt outmigration period. The Chinook salmon released to the Klamath River annually also likely result in deleterious effects on natural-origin populations, including competitive pressure between hatchery-derived and natural-origin fish in the limited habitat areas (e.g., thermal refugia) used by rearing juveniles in the Klamath River (NMFS 2010a). Iron Gate Hatchery releases Chinook salmon from the middle of May to the end of June, a period when discharge from Iron Gate Dam is in steep decline and water temperatures are rapidly rising, which may create competition between hatchery and natural-origin fish (Chinook salmon, coho salmon, and steelhead) for food and limited resources, especially limited space and resources in thermal refugia (NMFS 2010a). Negative hatchery effects due to competition, leading to displacement and lower growth, are well documented (Flagg et al. 2000, McMichael et al. 1997). In the Clackamas River, Oregon, hatchery steelhead released in the upper basin resulted in an exceedance of system carrying capacity, resulting in negative outcomes for natural-origin fish (Kostow et al. 2003 and Kostow and Zhou 2006), up to a 50 percent decline in the number of recruits per spawner, and a 22 percent decline in the maximum number of natural-origin recruits. These trends appear to have reversed after releases of hatchery fish were discontinued in 2000. Such density-dependent negative effects of hatchery-released fish can extend even into the marine environment, especially during periods of poor ocean conditions (Beamish et al. 1997a, Sweeting et al. 2003). Therefore, it is anticipated that the No Hatchery Alternative would result in reduced impacts to juvenile salmonids from resource competition.

Reservoir drawdown associated with dam removal under the No Hatchery Alternative could directly impact aquatic species. In addition, the removal of the Lower Klamath Project dams and reservoirs could alter the availability and quality of habitat in the Klamath River, resulting in direct and indirect effects on aquatic species. With a few exceptions, potential impacts under this alternative would be the same as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-1 through Potential Impact 3.3-24) since discontinuing hatchery operations in dam removal year 2 is the only difference between this alternative and the Proposed Project. While the Proposed Project includes continued operation of Iron Gate Hatchery for eight years using flows diverted from Bogus Creek (Section 3.3.5.9, Potential Impact 3.3-23) and the reopening of Fall Creek Hatchery for eight years using flows diverted from Fall Creek (Section 3.3.5.9, Potential Impact 3.3-24), the No Hatchery Alternative does not include continued hatchery operations, and thus there would be no flow diversions from Bogus Creek or Fall Creek and no change relative to existing conditions.

The No Hatchery Alternative includes aquatic resource measures described for the Proposed Project in Section 3.3.5.9, including AR-1 (Mainstem Spawning), AR-2 (Juvenile Outmigration), AR-6 (Suckers), and AR-7 (Freshwater Mussels). Similarly, mitigation measures AQR-1 (Mainstem Spawning) and AQR-2 (Juvenile Outmigration) (described in Section 3.3.5.9, Potential Impact 3.3-1) are included. However, Aquatic Resource Measure AR-4 (Iron Gate Hatchery Management) and Mitigation Measure AQR-3 (Bogus Creek Flow Diversions) would not be included, since both pertain to the Iron Gate Hatchery, which would not be operational under this alternative. Potential impacts to fish species currently propagated at Iron Gate Hatchery (i.e., fall-run Chinook salmon and coho salmon) that would differ from impacts described under the Proposed Project are discussed below.

Potential Impact 3.3-7 Effects on the fall-run Chinook salmon population due to short-term sediment releases and long-term changes habitat quality, habitat quantity, and hatchery operations due to dam removal.
In the short term, reservoir drawdown under the No Hatchery Alternative would result in elevated suspended sediment concentrations (SSCs) and altered sand and finer bedload sediment transport and deposition and would adversely impact fall-run Chinook salmon primarily in the Middle Klamath River downstream of Iron Gate Dam, as described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*). Also consistent with the Proposed Project, the effect of SSCs from the No Hatchery Alternative on the fall-run Chinook salmon population, under all scenarios, would not be expected to substantially reduce the population in the short term.

Under the No Hatchery Alternative, hatchery Chinook salmon smolts (age 0 released in spring) and yearlings (age 1 released in fall) would no longer be released into the Klamath River as occurs under existing conditions. From 1978 through 2016, returns of fall-run Chinook salmon adults to the Iron Gate Hatchery have ranged from 2,558 (in 1980) to 72,474 (in 2001), with an average of 16,559 fish (CDFW 2016b). During the same period, natural-origin returns in the Klamath River (not including Trinity River) ranged from 6,957 to 91,757 fall-run Chinook salmon, with an average of 31,379 fish (CDFW 2016a). While natural-origin returns typically outnumber hatchery returns, the proportion of the Chinook salmon escapement comprised of Iron Gate Hatchery returns has historically been substantial (~35 percent of age 3 adults; KRTT 2011, 2012, 2015). Eliminating the hatchery goal of releasing around 6 million Chinook salmon smolts and yearlings annually would likely result in a reduction in adult hatchery returns to the Klamath River. Most adult returns are age 3 (around 75 percent), with some age 4 (around 23 percent), and a few age 5 (<2 percent) fish (KRTT 2011, 2012, 2015). As a result, progeny of hatchery releases would likely return as adults, continuing mostly through post-dam removal year 1 (i.e., 4-year old returns, see Table 4.7-1). The first adult returns from the progeny of natural-origin fish fall-run Chinook salmon using newly accessible habitat upstream of Iron Gate Dam would be expected during post-dam removal year 3 (i.e., 3-year old returns); it is anticipated that initial returns would be low in abundance as the newly accessible habitat is gradually seeded. Based on historical data (CDFW 2016b), the reduction in returns could average around 16,000 fish beginning in post-dam removal year 3, as the population responds to the benefits of dam removal. Based on the current proportion of hatchery adults in the run, this could represent a short-term reduction in abundance of around 35 percent of age 3 adults on average until production from newly accessible habitat increases adult escapement (anticipated to begin in dam removal year 3, Table 4.6-1). However, depending on the year, the reduction could be as high as 50 percent (the proportion of hatchery return adult spawners in 1993 for example), or as low as 19 percent (the proportion in 1995) (KRTT 2015). The impact of a reduction in the number of hatchery returning fish is not equivalent to a reduction in the natural-origin population, from a population perspective. These adults are progeny of hatchery releases, and they typically return to the hatchery without contributing to the long-term sustainability of the fall-run Chinook salmon population. As discussed in detail in Section 3.3.2.3 *Habitat Attributed Expected to be Affected by the Proposed Project [Fish Hatcheries]*, hatchery returning adults can have substantial detrimental effects on native populations. As such, a reduction in hatchery returns under this alternative would be a benefit for fall-run Chinook salmon over the long term.

Under the No Hatchery Alternative, dam removal would increase habitat access for fall-run Chinook salmon, as described for the Proposed Project. As described in Section 3.3.5.9 *Aquatic Resource Impacts*, quantitative modeling of fall-run Chinook salmon populations suggests that the Proposed Project has a higher likelihood of resulting in increased Chinook salmon abundance than other management scenarios (e.g., continuation of existing conditions) (Oosterhout 2005, Huntington 2006, Dunsmoor and Huntington 2006, Hendrix 2011, Lindley and Davis 2011). Of the available models, the Hendrix (2011) life-cycle model (Evaluation of Dam Removal and Restoration of Anadromy [EDRRA]) approach is considered the most intensive and robust conducted to date. Since the model predictions are based on increased habitat access, the same gains would be expected for the No Hatchery Alternative as for the Proposed Project.

The rate at which recolonization and full post-dam removal fish production occurs would be partially dependent on the number of fish (natural-origin and hatchery strays) available and their ability to persist and adapt to the new habitat conditions. Although eight years of additional hatchery production under the Proposed Project is anticipated to achieve the production levels predicted by the EDRRA model sooner than without continued hatchery production, immediate closure of Iron Gate Hatchery and no production at Fall Creek Hatchery would eliminate most interbreeding of hatchery and natural-origin salmon by post-dam removal year 3, and would likely increase the rate at which Chinook salmon develop traits adapted to their new habitats upstream of Iron Gate Dam (Goodman et al. 2011). This could increase survival of natural-origin Chinook salmon at a faster rate than with continued hatchery operations under the Proposed Project. Goodman et al. (2011) note that this effect would depend, in part, on the degree to which local Chinook salmon stocks have been integrated into the hatchery brood stock and the degree to which the current mixed hatchery and natural-origin spawning population has maintained genetic potential for life history diversity to adapt to conditions upstream of Iron Gate Dam.

As described above in Section 4.7.3 *Aquatic Resources*, mortality from disease has the potential be reduced under this alternative more quickly than under the Proposed Project, since the release of Chinook and coho salmon would cease in dam removal year 2, rather than after eight additional years of hatchery releases.

The cessation of juvenile fish releases from Iron Gate Hatchery may also significantly decrease the amount of competition for food resources and habitat space between hatchery-reared and natural-origin smolts and yearlings in the Klamath River. This would result in higher growth rates for natural-origin fish (McMichael et al. 1997), and thus larger size at ocean entry beginning in dam removal year 2. Smolt size is correlated with increased marine survival for Chinook salmon (Scheuerell et al. 2009, Feldhaus et al.

2016), which in conjunction with reduced competition with hatchery smolts in the marine environment (Sweeting et al. 2003), would likely result in increased adult returns as soon as post-dam removal year 2 (i.e., 3-year-old adult returns).

Summary
In the short term, elevated SSCs and altered sand and finer bedload sediment transport and deposition and would adversely affect fall-run Chinook salmon primarily in the Middle Klamath River downstream of Iron Gate Dam, as described for the Proposed Project (Potential Impact 3.3-7), but would not be expected to substantially reduce the population. However, the elimination of hatchery produced fall-run Chinook salmon would likely result in a reduction (averaging 35 percent, potentially ranging from 19 to 50 percent based on existing conditions) in adult returns beginning in post-dam removal year 3 and continuing for an indeterminate period of perhaps one to five years (i.e., short-term), before the benefits of dam removal predicted by the EDRRA model for adult fall-run Chinook salmon are realized. In comparison with the Proposed Project, the natural-origin Chinook salmon population may adapt more quickly to restored habitat and benefit sooner from decreased competition and disease interactions, potentially reducing the period of short-term impacts. Overall, based on data from 1985 through 2014 (KRRT 2015), natural-origin returns of adult fall-run Chinook salmon have always outnumbered hatchery adult returns in the Klamath River Basin, and hatchery returns have never been estimated to be greater than 50 percent of the escapement in any year and are typically around 35 percent. Furthermore, hatchery returning adults are considered detrimental to the sustainability of natural spawning populations. Therefore, no substantial (> 50 percent) reduction in fall-run Chinook salmon abundance of a year-class is predicted to occur in the short term and this alternative would result in a less than significant impact.

In the long term, removal of the Lower Klamath Project dams under the No Hatchery Alternative would increase habitat availability, restore a more natural flow regime and seasonal variation in water temperature, improve water quality, and reduce the likelihood of fish disease and algal toxins, all of which would be beneficial for fall-run Chinook salmon. As described for the Proposed Project, if fish passage is not provided a Keno Impoundment/Lake Ewuana, restored habitat access to the Hydroelectric Reach and the multiple benefits of the Proposed Project would be beneficial for fall-run Chinook salmon in the long term. If fish passage were provided (per DOI [2007] fish passage prescriptions), an even greater magnitude of restored habitat access to the Upper Klamath River Basin and the multiple benefits of the No Hatchery Alternative would be beneficial for fall-run Chinook salmon in the long term.

Significance
No significant impact for fall-run Chinook salmon in the short term

Beneficial for fall-run Chinook salmon in the long term

Potential Impact 3.3-8 Effects on the spring-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.
In the short term, reservoir drawdown under the No Hatchery Alternative would increase SSCs and bedload sediment transport and deposition and impact spring-run Chinook salmon, as described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*). However, based on the distribution of spring-run Chinook salmon in the lower

Klamath River Basin (e.g., within the Salmon and Trinity rivers), the overall effect of suspended sediment from the Proposed Project on the spring-run Chinook salmon population is not anticipated to differ substantially from existing conditions. Also consistent with the Proposed Project, no reduction in the abundance of a year class is predicted in the short term.

Under the No Hatchery Alternative, coho and fall-run Chinook salmon yearlings and smolts would no longer be released into the Klamath River. There are currently no releases of spring-run Chinook salmon from hatcheries into the Klamath River. Therefore, the closure of the Iron Gate Hatchery is not anticipated to result in a decline in adult returns for spring-run Chinook salmon. However, as described above in Section 4.7.3 *Aquatic Resources*, outmigrant spring-run Chinook smolt mortality due to disease would be reduced under this alternative more quickly than under the Proposed Project, since the release of fall-run Chinook and coho salmon would cease in dam removal year 2, rather than after eight additional years of hatchery releases following dam removal. The cessation of juvenile fish releases from Iron Gate Hatchery in conjunction with dam removal may also significantly decrease the amount of competition for food resources and habitat space between hatchery-reared and natural-origin smolts in the Klamath River. This would result in higher growth rates for natural-origin fish (McMichael et al. 1997) and thus larger size at ocean entry beginning in dam removal year 2. Smolt size is correlated with increased marine survival for Chinook salmon (Scheuerell et al. 2009, Feldhaus et al. 2016), which in conjunction with reduced competition with hatchery smolts in the marine environment (Sweeting et al. 2003) is anticipated to result in increased adult returns as soon as post-dam removal year 2 (i.e., 3-year-old adult returns). Therefore, ending hatchery operations under this alternative may result in a more rapid increase in the spring-run Chinook salmon adult population as a result of dam removal than under the Proposed Project.

Summary

In the short term, elevated SSCs and bedload sediment transport and deposition would adversely impact spring-run Chinook salmon, but based on the distribution of spring-run Chinook salmon in the lower Klamath River Basin (e.g., within the Salmon and Trinity rivers) the overall effect on the population is not anticipated to differ substantially from existing conditions and no reduction in the abundance of a year class is predicted.

Under the No Hatchery Alternative, the elimination of hatchery produced salmonids would not affect spring-run Chinook salmon adult returns in the short term. As described for the Proposed Project, this alternative includes aquatic resource measure AR-2 (Juvenile Outmigration) to reduce the short-term effects of SSCs on spring-run Chinook salmon smolts. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measure AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4 (Section 3.3.5.9 *Aquatic Resource Impacts*), would even further reduce the potential for short-term effects of the No Hatchery Alternative on spring-run Chinook salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measure. With implementation of resource measures, there would still be short-term impacts on spring-run Chinook salmon, including some potential direct mortality, but there would not be a substantial reduction in the abundance of a year class. The impact of the No Hatchery Alternative would be less than significant for spring-run Chinook salmon in the short term.

In the long term, removal of the Lower Klamath Project dams under the No Hatchery Alternative would improve habitat availability, flow regime, water quality, seasonal water temperature variation, and would reduce or eliminate algal toxins, all of which would benefit spring-run Chinook salmon. Dam removal would restore connectivity to hundreds of miles of historical habitat in the Upper Klamath Basin and would create additional habitat within the Hydroelectric Reach. The No Hatchery Alternative would be beneficial for spring-run Chinook salmon in the long term.

Significance

No significant impact for spring-run Chinook salmon in the short term

Beneficial for spring-run Chinook salmon in the long term

Potential Impact 3.3-9 Effects on coho salmon populations due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

In the short term, reservoir drawdown under the No Hatchery Alternative would increase SSCs and bedload sediment transport and deposition and impact coho salmon, as described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts; Potential Impact 3.3-9*). In general, the wide distribution and use of tributaries by both juvenile and adult coho salmon would likely protect the population from the worst short-term impacts of this alternative. However, direct mortality is anticipated for redds from the Upper Klamath River Population Unit (at most 13 redds based on historic data, see Appendix E). As described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*; Potential Impact 3.3-9), no mortality is anticipated for the other population units.

Under the No Hatchery Alternative, hatchery coho salmon smolts (age 1 released in fall) would no longer be released into the Klamath River. Iron Gate Hatchery has a goal to produce 75,000 coho salmon smolts on an annual basis, although that goal has only been met in three of the last seven years (2011–2017). Overall, coho salmon yearling smolt goals are achieved on average (K. Pomeroy, CDFW, pers. comm., 2018). Based on current production levels, ceasing operations would likely result in a reduction of up to 75,000 coho salmon smolts per year beginning in dam removal year 2 (Table 4.7-1). Based on the current low abundance of coho salmon in the upper Klamath River population unit, a conservation focus for the coho salmon program has been deemed necessary to protect the remaining genetic resources of that population unit (CDFW 2014). Coho salmon adult returns to Iron Gate Hatchery have significantly and steadily declined from a high of 2,466 adults in the 2001/2002 return year to 38 adults in the 2015/2016 return year, with an annual average of 866 (CDFW 2016b). Assuming coho smolts would be released for the last time in dam removal year 1 (Table 4.7-1), adults of hatchery progeny would continue to return through post-dam removal year 1 (as age 3 adults). Based on the average coho salmon smolt-to-adult survival ratio of 0.99 percent estimated for current coho salmon Iron Gate Hatchery operations (CDFW 2014), a reduction in the release of 75,000 coho salmon smolts following closure of Iron Gate Hatchery could result in a decline of around 743 adult returns on average annually starting in post-dam removal year 2 (Table 4.7-1). These adults would return to the Iron Gate Hatchery, but also stray into tributaries (primarily Bogus Creek) and spawn naturally. Between 2004 and 2011 an average of 46 coho salmon hatchery adults per year strayed into Bogus Creek (CDFW 2014).

Under existing conditions, CDFW (2014) estimates that greater than 30 percent on average of the total adult returns to the Upper Klamath River are of hatchery origin, including greater than 70 percent of returns to the hatchery, around 34 percent of returns to Bogus Creek, and around 16 percent of returns to tributaries such as the Shasta and Scott rivers. The natural abundance of coho salmon adults in the Upper Klamath Population Unit is less than 200 fish, and in some years the majority of natural-origin spawning is from adults of hatchery origin (CDFW 2014).

Assuming that hatchery production ceases in dam removal year 1, the total reduction in coho salmon returns in post-dam removal year 2 (i.e., after hatchery returns have ended and prior to realization of dam removal habitat benefits) would vary depending on population unit, and it could be substantial (> 50 percent) in the Upper Klamath River Population Unit depending on strength of the natural-origin returning spawners. Reductions are anticipated to be less than substantial (< 20 percent reduction) for the other population units. While the impact could be substantial for the upper Klamath River coho salmon population unit In the short term, the overall short-term impact on coho salmon populations in the Klamath River Basin would not be substantial. In addition, the impact of a reduction in the number of hatchery returning fish is not equivalent to a reduction in the natural spawning population, from a population perspective. These adults are progeny of hatchery releases, and typically return to the hatchery without contributing to the long-term sustainability of the coho salmon population. As discussed in detail in Section 3.3.2.3 *Habitat Attributed Expected to be Affected by the Proposed Project [Fish Hatcheries]*, hatchery returning adults can have substantial detrimental effects on native populations; as addressed by CDFWs plan to operate the hatchery for coho salmon conservation (CDFW 2014).

In addition, and as described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project* and summarized in CDFW (2014), there are adverse hatchery-related effects on the coho salmon population, including straying of Iron Gate Hatchery fish into important tributaries with the potential to reduce the reproductive success of the natural population (Mclean et al. 2003, Chilcote 2003, Araki et al. 2007) and negatively affect the diversity of the interior Klamath populations via outbreeding depression[231] (Reisenbichler and Rubin 1999). As described above in Section 4.7.3 *Aquatic Resources*, outmigrant smolt mortality from disease would be reduced under the No Hatchery Alternative more quickly than under the Proposed Project, since the release of Chinook and coho salmon would cease in dam removal year 2, rather than after eight additional years of hatchery releases. The cessation of juvenile fish releases from Iron Gate Hatchery may also significantly decrease the amount of competition for food resources and habitat space between hatchery-reared and natural-origin spawned smolts in the Klamath River. This would result in higher growth rates for natural-origin spawned fish (McMichael et al. 1997), and thus larger size at ocean entry beginning in dam removal year 2. Smolt size is correlated with increased marine survival for coho salmon (Holtby et al. 1990), which in conjunction with reduced competition with hatchery smolts in the marine environment (Sweeting et al. 2003) would likely result in increased adult returns as soon as post-dam removal year 2 (i.e., 3-year-old adult returns). Therefore, ending hatchery operations as part of dam removal may result in a more rapid increase in the adult coho salmon population as compared with the Proposed Project.

[231] Outbreeding depression is progeny that are less adapted to the environment than parents.

As described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-9), under the No Hatchery Alternative, dam removal and the associated habitat improvements would likely result in an increase in coho salmon abundance. The first adults that could potentially access the newly available habitat upstream of Iron Gate Dam would occur in dam removal year 2, and they would produce progeny benefiting from improved river function in post-dam removal year 1. Therefore, the first adult returns that could reflect the improved habitat conditions would occur in post-dam removal year 4 (i.e., as age 3 adults).

Summary

In the short term, reservoir drawdown under the No Hatchery Alternative would increase SSCs and bedload sediment transport and deposition and adversely impact coho salmon, as described for the Proposed Project. In general, the wide distribution and use of tributaries by both juvenile and adult coho salmon would likely protect the population from the worst short-term impacts of this alternative. However, direct mortality is anticipated for redds from the Upper Klamath River Population Unit (at most 13 redds based on historic data, see Appendix E). No mortality is anticipated for the other population units.

The elimination of hatchery produced coho salmon would likely result in a reduction in adult returns for a period of one to five years before the benefits of dam removal are realized. Compared with the Proposed Project, the natural coho salmon population would benefit sooner from decreased competition and disease interactions once hatchery releases are eliminated, which would potentially reduce the period of short-term impacts under the No Hatchery Alternative. However, in post-dam removal years 2 and 3 (at a minimum), there would be a 10 to 30 percent reduction in adult returns (depending on population unit), since this would be after hatchery returns have ended, and prior to the first adults capable of realizing the benefits of dam removal (Table 4.6-1). In addition, closure of the coho salmon hatchery program at Iron Gate Hatchery in dam removal year 1 would result in cessation of the genetic management plan's goal of improving diversity and fitness of Klamath River coho salmon (CDFW 2014). Overall, because there would not be a predicted substantial short-term decrease in coho salmon abundance of a year class, nor would there be a substantial decrease in habitat quality or quantity, there would not be a significant impact to coho salmon under the No Hatchery alternative in the short term.

In addition, and as described for the Proposed Project, although there would be no significant impact on coho salmon In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the No Hatchery Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including coho salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4 (Section 3.3.5.9 *Aquatic Resource Impacts*), would even further reduce the potential for short-term effects of the No Hatchery Alternative on coho salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

In the long term, removal of the Lower Klamath Project dams under the No Hatchery Alternative would improve habitat availability, flow regime, water quality, seasonal temperature variation, and reduce fish disease incidence and algal toxins, all of which would benefit coho salmon. Dam removal would restore connectivity to habitat on the mainstem Klamath River up to and including Spencer Creek and would create additional habitat within the Hydroelectric Reach. Dam removal would also cause water temperatures to become warmer earlier in the spring and early summer, cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperatures that are more favorable for salmonids in the mainstem.

In the long term, increased adult returns resulting from newly accessible habitat upstream of Iron Gate Dam would offset reductions in adult returns due to cessation of hatchery operations. It is anticipated that as a result of the No Hatchery Alternative, the coho salmon population would experience an increase in abundance, productivity, population spatial structure, and genetic diversity. In general, free flowing river conditions under the No Hatchery Alternative would likely increase adult migration efficiency, decrease outmigrant delay, and increase adult escapement (Buchanan et al. 2011b). The increases associated with dam removal would result in overall increases in the abundance and viability of the coho salmon from all Klamath River population units in the long term.

Significance

No significant impact for coho salmon populations in the short term

Beneficial for coho salmon from all Klamath River population units in the long term

4.7.4 Phytoplankton and Periphyton

The No Hatchery Alternative would have the same potential short-term and long-term impacts on phytoplankton and periphyton as those described for the Proposed Project (Potential Impacts 3.4-1 through 3.4-5). The primary changes to the existing phytoplankton and periphyton conditions under both the Proposed Project and the No Hatchery Alternative are from dam removal and the shift in dynamics from a reservoir system to a riverine system in the Hydroelectric Reach. The difference between the No Hatchery Alternative and either existing conditions or the Proposed Project results from ending operations at Iron Gate Hatchery and not restarting operations at Fall Creek Hatchery. Under the No Hatchery Alternative, discharges from Iron Gate Hatchery, including nutrient discharges, under existing conditions and the Proposed Project would cease. While Iron Gate Hatchery nutrient releases would decrease under the No Hatchery Alternative, the hatchery nutrient discharges are less-than-significant based on an analysis of the water quality impacts of California Department of Fish and Wildlife hatcheries, including Iron Gate Hatchery (ICF 2010) and decreases in hatchery nutrient releases would not necessarily result in a beneficial effect on phytoplankton or periphyton conditions downstream of the hatchery discharge. Thus, phytoplankton and periphyton conditions under the No Hatchery Alternative with no nutrient releases from Iron Gate Hatchery discharges would be similar to existing conditions or the Proposed Project. Potential impacts to dissolved oxygen and water temperature in Fall Creek under the Proposed Project (see Potential Impact 3.2-17) would be eliminated under this alternative since the fish production at Fall Creek Hatchery would not restart and the hatchery discharges would not occur.

Overall, ceasing production and removing Iron Gate Hatchery and not reopening Fall Creek Hatchery under the No Hatchery Alternative would result in no significant difference in phytoplankton and periphyton growth relative to existing conditions or the Proposed Project, thus there would be no significant impact on phytoplankton and periphyton under the No Hatchery Alternative.

4.7.5 Terrestrial Resources

Full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts to terrestrial resources as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. Further, not operating the hatcheries under this alternative would have no bearing on the anticipated long-term changes in terrestrial habitat that would result from removal of the Lower Klamath Project dams, reservoirs, and associated facilities. Therefore, the No Hatchery Alternative would have the same short-term and long-term potential impacts on vegetation communities, culturally significant species, special-status species, wildlife corridors, and habitat connectivity as those described for the Proposed Project (Potential Impacts 3.5-1 through 3.5-24 and 3.5-28 through 3.5-30).

While the Proposed Project includes continued operation of Iron Gate Hatchery for eight years using flows diverted from Bogus Creek (Potential Impact 3.5-26) and the reopening of Fall Creek Hatchery for eight years using flows diverted from Fall Creek (Potential Impact 3.5-27), the No Hatchery Alternative does not include continued hatchery operations, and thus there would be no flow diversions from Bogus Creek or Fall Creek and no impact (no change from existing conditions). Potential impacts on wildlife due to the loss of salmon currently propagated at Iron Gate Hatchery (i.e., fall-run Chinook salmon and coho salmon), which would differ from impacts described under the Proposed Project, is discussed below.

Potential Impact 3.5-25 Effects on wildlife from increased habitat for salmonids and changes in hatchery production.
Full removal of the Iron Gate Hatchery, which currently releases fall-run Chinook and coho salmon smolts and contributes to returning adults, may reduce prey availability for special-status wildlife in the short term. Special-status wildlife such as bald eagle, Barrow’s goldeneye, common loon, and western pond turtle may forage on out-migrating natural and hatchery-produced salmonids and/or on returning adult carcasses.

Under the No Hatchery Alternative, there would be a reduction of outmigrating yearlings and smolts compared to existing conditions. No data are available to accurately estimate the number of naturally produced smolts in the watershed in comparison with hatchery production, but based on adult returns (Section 3.3.2 *[Aquatic Resources] Environmental Setting*), hatchery-origin out-migrating yearlings and smolts currently comprise approximately 35 percent of all fall-run Chinook salmon smolts outmigrating in the mainstem Klamath River (Section 4.7.2, Potential Impact 3.3-7), and around 30 percent on average of the total coho salmon smolt production (Section 4.7.2, Potential Impact 3.3-9). Thus, under this alternative, beginning in dam removal year 2 hatchery juveniles would not be released during the natural spring smolt outmigration period and prey availability for raptors and mammals during this period would be reduced by over 30 percent. Yearling and smolt production would begin to increase again following dam removal (i.e., post-dam removal year 1) since both (previously released) hatchery and natural-origin adults would have access to new habitat for spawning. Production would occur in post-dam removal year 1 (see also Section 3.3.5.6 *Fish Hatcheries*), and on average would be expected to increase the availability of outmigrating salmonids as prey for wildlife each year following dam removal.

With respect to adult returns, the elimination of hatchery produced fall-run Chinook salmon would likely result in a reduction (averaging 35 percent, potentially ranging from 19 to 50 percent based on existing conditions) in adult returns in the fall beginning in post-dam removal year 3 and continuing for an indeterminate period of perhaps one to five years (i.e., short-term), before the benefits of dam removal are realized (see Section 4.7.3 *Aquatic Resources*, Potential Impact 3.3-7). The elimination of hatchery produced coho salmon would likely result in a reduction in adult returns for a period of one to five years before the benefits of dam removal are realized (see Section 4.7.3 *Aquatic Resources*, Potential Impact 3.3-9).

Although a variety of wildlife prey directly forage on outmigrating smolts or adult returns originating from Iron Gate Hatchery, bald eagles would be the most likely state-listed special-status species to do so in the Klamath Basin; other state species of special concern that forage on fish include the western pond turtle, Barrow's goldeneye, and common loon. Bald eagles are opportunistic foragers and hunt mainly for fish and waterfowl, but will also feed on small mammals and other small vertebrates and carrion (see also Potential Impact 3.5-21). Similarly, the diet of other state species of special concern includes prey items other than fish. For example, western pond turtles forage on aquatic plants, benthic macroinvertebrates, frogs, and crayfish(see also Potential Impact 3.5-20); Barrow's goldeneye primarily eat aquatic invertebrates and fish eggs (Cornell Lab of Ornithology 2017a); and the common loon also feeds on crustaceans, snails, and aquatic insect larvae (Cornell Lab of Ornithology 2017b).

While the anticipated peak reduction in availability of hatchery-origin outmigrating smolts would occur during spring of dam removal year 2, there would also be an enhanced opportunity for these species to consume stranded or dead fish during and following reservoir drawdown (winter through spring of dam removal year 2) (Potential Impact 3.5-21). Further, these species would continue to forage on natural-origin outmigrating salmonids elsewhere in the basin (e.g., Scott, Shasta, Salmon, Trinity rivers) and would utilize alternate food sources as described above. Overall, the anticipated peak reduction in outmigrating smolts in dam removal year 2 under this alternative would not significantly affect the ability of these special-status species to perform essential feeding behaviors. Similarly, although adult returns would be reduced on average by 35 percent for fall-run Chinook beginning in post-dam removal year 3 and continuing for one to five years, bald eagles that regularly forage in the Middle and Lower Klamath River, and/or the Klamath River Estuary, would still have access to alternate food sources such as small mammals and birds such that this alternative would not significantly affect the ability of this species to perform essential feeding behaviors three to five years following dam removal. Thus, there would be no significant impact in the short term.

In the long term, dam removal would result in increased adult returns for fall-run Chinook and coho salmon due to restored connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin and creation of additional spawning and rearing habitat within the Hydroelectric Reach, as well as improved habitat quality (i.e., more natural flow regime and seasonal variation in water temperature, improved water quality, reduced likelihood of fish disease and algal toxins). These long-term effects would be beneficial for fall-run Chinook salmon and would offset short-term reductions in adult returns due to cessation of hatchery operations under this alternative. In the long term, the increased abundance and productivity of these adult, juvenile, and out-migrating salmon species would result in an increased prey base and would be beneficial for bald eagles, Barrow's goldeneye, and western pond turtles. Similar conditions would occur for other fish-eating wildlife, including a variety of birds (osprey, merganser, cormorant, egret, heron) and mammals (otters, bears), such that overall there would be no short-term or long-term significant impacts on wildlife due to the loss of hatchery production under this alternative.

Significance

No significant impact in the short term or long term

4.7.6 Flood Hydrology

Removing Iron Gate Hatchery and not reopening Fall Creek Hatchery under the No Hatchery Alternative would not affect river flood stages or flood flow conditions relative to the Proposed Project. Therefore, the flood hydrology impacts of the No Hatchery Alternative would be the same as those described for the Proposed Project (Section 3.6.5 *[Flood Hydrology] Potential Impacts and Mitigation*) and there would be no significant impacts relative to existing conditions for Potential Impacts 3.6-1, 3.6-2, and 3.6-4 through 3.6-6. For reasons described in the Proposed Project, there would be significant and unavoidable impacts relative to existing conditions from exposing structures to a substantial risk of damage due to flooding in the reach between Iron Gate Dam (RM 193) and Humbug Creek (RM 174) (Potential Impact 3.6-3).

4.7.7 Groundwater

Removing Iron Gate Hatchery and not reopening Fall Creek Hatchery under the No Hatchery Alternative would not affect groundwater levels or wells immediately adjacent (potentially extending up to a mile from the reservoirs under certain conditions) to Copco No. 1 and Iron Gate reservoirs relative to the Proposed Project. Therefore, the groundwater impacts of the No Hatchery Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.7-1 and 3.7-2) and there would be no significant impacts relative to existing conditions.

4.7.8 Water Supply/Water Rights

Under the No Hatchery Alternative, the Bogus Creek water diversion of up to 8.75 cfs to operate Iron Gate Hatchery, and the Fall Creek water diversion of up to 9.24 cfs to reopen and operate Fall Creek Hatchery (Section 2.7.6 *Hatchery Operations*), would not occur. However, since water proposed to be diverted for the Iron Gate and Fall Creek Hatcheries under the Proposed Project would be for non-consumptive uses, and therefore would not change the amount of water available for diversion downstream, the lack of these diversions under the No Hatchery Alternative would result in no difference relative to either the Proposed Project or existing conditions. Removing Iron Gate Hatchery and not reopening Fall Creek Hatchery under the No Hatchery Alternative would not otherwise affect the amount of surface water flow available for diversion compared to the Proposed Project; therefore, the effects of the No Hatchery Alternative on the amount of water available for diversion in the Klamath River would be the same as those described for the Proposed Project (Potential Impacts 3.8-1, 3.8-2, and 3.8-5) and there would be no significant impacts.

Under the No Hatchery Alternative, mobilization of reservoir sediment deposits during reservoir drawdown would occur as described for the Proposed Project, such that release of stored sediment could impact water intake pumps downstream from Iron Gate Dam (Potential Impact 3.8-3) and there would be a significant impact. Implementation of Mitigation Measure WSWR-1 would result in no significant impact.

The City of Yreka's municipal water supply pipeline would still need to be relocated following drawdown of Iron Gate Reservoir under the No Hatchery Alternative, and as described for the Proposed Project there would be potential for disruption to the City's water supply, which would be a significant impact. Implementation of Mitigation Measure WSWR-2 would result in no significant impact.

4.7.9 Air Quality

Full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts related to air pollutants as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. Therefore, the No Hatchery Alternative would have the same short-term construction-related emissions of air pollutants (i.e., VOCs, CO, NOx, SOs, PM_{10}, $PM_{2.5}$) as those described for the Proposed Project (Potential Impacts 3.9-1 through 3.9-5). Like the Proposed Project, construction activities occurring under the No Hatchery Alternative would exceed the Siskiyou County Air Pollution Control District emissions thresholds and would result in a significant and unavoidable impact.

Note that analysis of the Proposed Project considers only construction-related air quality impacts because no changes in operational sources are part of the Proposed Project (Section 3.9.4 *[Air Quality] Impact Analysis Approach*). Under the Proposed Project, operational emissions for the reduced operation of Iron Gate Hatchery combined with the re-instated operation of Fall Creek Hatchery are assumed to be the same as existing operation conditions at Iron Gate Hatchery for eight years following dam removal, since the existing functions at the Iron Gate Hatchery that would be eliminated as part of dam removal activities, would be replaced by the reopening and operation of the Fall Creek Hatchery and by making improvements to the Iron Gate Hatchery (Section 2.7.6 *Hatchery Operations*). Thus, as a matter of general comparison, under the No Hatchery Alternative, operational emissions from the hatcheries would be lower (zero) than those under existing conditions. Since the existing operational emissions from Iron Gate Hatchery are not quantified, a beneficial significance determination may not be supported and the alteration in emissions under the No Hatchery Alternative would result in no significant impact.

4.7.10 Greenhouse Gas Emissions

Full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts related to greenhouse gas emissions as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. Therefore, the No Hatchery Alternative would have the same short-term construction-related potential impacts on greenhouse gas emissions as those described for the Proposed Project (Potential Impacts 3.10-1 and 3.10-2) and would result in no significant impact on greenhouse gas levels relative to existing conditions.

Note that analysis of the Proposed Project assumes that energy use associated with the reduced operation of Iron Gate Hatchery combined with the re-instated operation of Fall Creek Hatchery would be the same as existing conditions operations at Iron Gate Hatchery for the eight years following dam removal, since the existing functions at the Iron Gate Hatchery that would be eliminated as part of dam removal activities would be replaced by the reopening and operation of the Fall Creek Hatchery and by making improvements to the Iron Gate Hatchery (Section 2.7.6 *Hatchery Operations*). Thus, as a matter of general comparison, under the No Hatchery Alternative, operational emissions from the hatcheries would be lower (zero) than those under existing conditions. Since the existing operational emissions from Iron Gate Hatchery are not quantified, a beneficial significance determination may not be supported and the alteration in emissions under the No Hatchery Alternative would result in no significant impact.

4.7.11 Geology, Soils, and Mineral Resources

Removing Iron Gate Hatchery and not reopening Fall Creek Hatchery under the No Hatchery Alternative would not affect geologic hazards, short-term soil disturbance, earthen dam embankment instability, or mineral resource availability relative to the Proposed Project. Therefore, the effects of the No Hatchery Alternative on geology and soils would be the same as those described for the Proposed Project (Potential Impacts 3.11-1, 3.11-2, and 3.11-4 through 3.11-8) and there would be no significant impacts relative to existing conditions. For reasons described in Section 3.11.5 *[Geology, Soils, and Mineral Resources] Potential Impacts and Mitigation*, Implementation of Recommended Measure GEO-1 would be necessary to reduce the potential impacts resulting from slope failure in reservoir rim areas at Copco No. 1 Reservoir (see Potential Impact 3.11-3). With implementation of Mitigation Measure GEO-1, there would be no significant impacts due to the potential for hillslope instability at Copco No. 1 Reservoir during drawdown and the year following drawdown.

4.7.12 Historical Resources and Tribal Cultural Resources

Since the Lower Klamath Project dams and associated facilities would be removed in the same manner under the No Hatchery Alternative as the Proposed Project, potential impacts and associated mitigation measures under the No Hatchery Alternative would be the same as those described for the Proposed Project, Section 3.12.5 *[Historical Resources and Tribal Cultural Resources] Potential Impacts and Mitigation*, except for the differences discussed below.

Since the Iron Gate Hatchery would not be operated for eight years following dam removal, the portion of the Limits of Work containing the Iron Gate Hatchery footprint (Figure 2.7-4) would be returned to more natural conditions In the short term, which would be beneficial relative to existing conditions and the Proposed Project. Further, since construction/upgrading activities would not occur at Fall Creek Hatchery, there would be no pre-dam removal construction activities (Potential Impact 3.12-1) at the Fall

Creek site and thus no significant impacts to known or as yet unknown tribal cultural resources (Potential Impact 3.12-1) or historic-period archaeological resources (Potential Impact 3.12-12) relative to existing conditions, and fewer impacts relative to the Proposed Project.

Full removal of the Iron Gate Hatchery, which currently releases salmonid smolts and contributes to returning adults, and not reopening Fall Creek Hatchery, would reduce the amount of Fall-run Chinook and coho salmon present for California Native American tribes that currently use salmon in their diet and consider salmon to be an important part of their culture (Potential Impact 3.12-10). The elimination of hatchery produced fall-run Chinook salmon under this alternative would likely result in a reduction (averaging 35 percent, potentially ranging from 19 to 50 percent based on existing conditions) in adult returns in the fall beginning in post-dam removal year 3 and continuing for an indeterminate period of perhaps one to five years (i.e., short-term), before the benefits of dam removal are realized (see Section 4.7.3 *Aquatic Resources*, Potential Impact 3.3-7). The elimination of hatchery produced coho salmon would likely result in a reduction in adult returns for a period of one to five years before the benefits of dam removal are realized (see Section 4.7.3 *Aquatic Resources*, Potential Impact 3.3-9). This potential impact to the fishery would be greater than under the Proposed Project, because under the Proposed Project the hatcheries would continue to supplement natural adult returns (albeit at a reduced rate of production) until after seven generations or cohorts of fish have been hatched with the benefit from expanded habitat and improved water quality conditions. However, the short term reduction in the fishery due to elimination of hatchery-produced fall-run Chinook and coho salmon under the No Hatchery Alternative would represent a material impairment of the Klamath Riverscape as a resource and a substantial restriction of tribal access to the fishery relative to existing conditions.

In the long term, increased adult returns for fall-run Chinook and coho salmon resulting from restored connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin and creation of additional spawning and rearing habitat within the Hydroelectric Reach, as well as improved habitat quality (more natural flow regime and seasonal variation in water temperature, improved water quality, reduced likelihood of fish disease and algal toxins), would be beneficial for fall-run Chinook salmon and coho salmon and would offset reductions in adult returns due to cessation of hatchery operations under this alternative (Section 4.7.3 *Aquatic Resources*, Potential Impacts 3.3-7 and 3.3-9). Additionally, the populations of other salmonids are expected to benefit from expanded habitat, improved water quality, reduced disease factors and decreased competition from hatchery fish. The increased abundance and productivity of these salmon species would result in an increase in availability of salmon for California Native American tribes and would be beneficial in the long term.

4.7.13 Paleontologic Resources

Removing Iron Gate Hatchery and not reopening Fall Creek Hatchery under the No Hatchery Alternative would not affect downcutting or erosion of the Hornbrook Formation located downstream of Iron Gate Dam relative to the Proposed Project. Therefore, the effects of the No Hatchery Alternative on paleontologic resources would be the same as those described for the Proposed Project (Potential Impact 3.13-1) and there would be no significant impacts relative to existing conditions.

4.7.14 Land Use and Planning

Overall, under the No Hatchery Alternative, potential impacts on connectivity between areas of a community in California would be the same as those described for the Proposed Project in Section 3.14.5 *[Land use and Planning] Potential Impacts and Mitigation*. The California dam removal actions and California land transfer and management for public interest purposes would occur in the same manner under both the No Hatchery Alternative and under the Proposed Project.

4.7.15 Agriculture and Forestry Resources

Fully removing Iron Gate Hatchery and not reopening Fall Creek Hatchery under the No Hatchery Alternative would not affect agriculture and forestry management relative to the Proposed Project or to the existing condition. Therefore, effects of the No Hatchery Alternative on agriculture and forestry resources would be the same as those described for the Proposed Project (Potential Impact 3.15-1 through 3.15-3), and there would be no significant impacts relative to existing conditions.

4.7.16 Population and Housing

Full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts related to population and housing as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. Construction activities are the only part of the Proposed Project and this alternative that merit analysis for potential impacts on population and housing. The number of construction workers in California would be the same as those described for the Proposed Project and would not result in a substantial influx of population (Potential Impact 3.16-1), nor would there be a need to displace existing residents or build replacement housing elsewhere (Potential Impact 3.16-2), and there would be no significant impacts relative to existing conditions.

4.7.17 Public Services

Overall, under the No Hatchery Alternative, potential impacts on public services in California would be the same as those described for the Proposed Project. The California dam removal actions and California land transfer and management for public interest purposes would occur in the same manner under both the No Hatchery Alternative and under the Proposed Project. Thus, for reasons described in Section 3.17.5 *[Public Services] Potential Impacts and Mitigation*, impacts and associated mitigation measures from increased public service response times for emergency fire, police, and medical services due to construction and demolition activities, elimination of a long-term water source for wildfire services substantially increasing the response time for suppressing wildfires, and potential effects on schools services and facilities would be the same under the No Hatchery Alternative as those described for the Proposed Project (Potential Impacts 3.5-1 through 3.5-3).

4.7.18 Utilities and Service Systems

Full removal of the Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts related to utilities and services systems as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. Construction activities are the only part of the Proposed Project and this alternative that merit analysis for potential impacts on utilities and service systems. For reasons described in Section 3.18.5 *[Utilities and Service Systems] Potential Impacts and Mitigation Measures*, there would be no significant impacts on utilities and service systems related to this degree of construction under the Proposed Project or this alternative. Construction-related activity in California would still require the need for onsite wastewater treatment, stormwater drainage, and/or solid waste disposal facilities at the same level as the Proposed Project (Potential Impacts 3.18-1 through 3.18-4) and would result in no significant impacts relative to existing conditions.

4.7.19 Aesthetics

Full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts related to aesthetics as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. Short-term and long-term impacts on aesthetic resources, including a loss of open water and lake vistas in favor of more natural river, canyon, and valley vistas (Potential Impact 3.19-1) and changes in river flows, channel morphology, and visual water quality (Potential Impact 3.19-2 and 3.19-3) would be the same as described for the Proposed Project. Short-term visual changes resulting from reservoir drawdown would be the same as described for the Project (Potential Impact 3.19-4).

Under the No Hatchery Alternative, visual changes resulting from the removal of the Lower Klamath Project dams and associated facilities would be the same as the Proposed Project (Potential Impact 3.19-5) with the exception of the portions of the Limits of Work that contain the Iron Gate Hatchery and Fall Creek Hatchery footprints. Since Iron Gate Hatchery would not be operated for eight years following dam removal, the portion of the Limits of Work containing the Iron Gate Hatchery footprint (Figure 2.7-13) would be returned to more natural conditions in the short term. This would be beneficial relative to existing conditions and the Proposed Project. Since construction/upgrading activities would not occur at the Fall Creek Hatchery, there would be no impact (no change from existing conditions) and a small reduction in short-term impacts on aesthetic resources for the portion of the Limits of Work containing the Fall Creek Hatchery footprint (Figure 2.7-15) relative to the Proposed Project.

Other short-term visual impacts of construction activities (Potential Impact 3.19-6) and nighttime views during short-term construction activities (Potential Impact 3.19-7) would be the same as those described for the Proposed Project.

4.7.20 Recreation

Full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts related to recreation as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. Thus, potential impacts would be the same as those described for the Proposed Project (Potential Impacts 3.20-1 through 3.20-3, 3.20-5) and there would be no significant impact. Loss of hatchery operations would not affect flows in the Hydroelectric Reach, such that the loss of whitewater boating opportunities in the Hell's Corner Reach (within the upper portion of the Hydroelectric Reach) would be the same as the Proposed Project (Proposed Impact 3.20-5) and would be significant and unavoidable. There would be no significant impact in the Middle and Lower Klamath River.

Full removal of the Iron Gate Hatchery, which currently releases salmonid smolts and contributes to returning adults, and not reopening Fall Creek Hatchery, would reduce the amount of salmon present for river-based recreational fishing in the short term (Potential Impact 3.20-6). The elimination of hatchery produced fall-run Chinook salmon under this alternative would likely result in a reduction (averaging 35 percent, potentially ranging from 19 to 50 percent based on existing conditions) in adult returns in the fall beginning in post-dam removal year 3 and continuing for an indeterminate period of perhaps one to five years (i.e., short-term), before the benefits of dam removal are realized (see Section 4.7.3 *Aquatic Resources*, Potential Impact 3.3-7). Most of the recreational river fishing access sites along the Middle Klamath River are rated as light usage (see Section 3.20.2.2 *Klamath River-based Recreation – Middle and Lower Klamath River – Fishing Opportunities*) and species caught by recreational fishers in the Middle and Lower Klamath River include steelhead and trout, in addition to Chinook salmon. Further, adult Chinook salmon returning to Klamath River tributaries (Table 3.20-2) (i.e., natural origin salmon) would still be available as a recreational fishing opportunity. Overall, the 35 percent reduction (on average) in available fall-run Chinook salmon beginning in post-dam removal year 3 and continuing for one to five years under this alternative would not result in changes to or loss of rare or unique recreational facilities affecting a large area or substantial number of people; therefore, the short-term impacts would be less than significant.

In the long term, increased adult returns for fall-run Chinook salmon resulting from restored connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin and creation of additional spawning and rearing habitat within the Hydroelectric Reach, as well as improved habitat quality (more natural flow regime and seasonal variation in water temperature, improved water quality, reduced likelihood of fish disease and algal toxins), would be beneficial for fall-run Chinook salmon and would offset reductions in adult returns due to cessation of hatchery operations under this alternative (Section 4.7.3 *Aquatic Resources*, Potential Impacts 3.3-7 and 3.3-9). The increased abundance and productivity of these salmon species would result in an increase in availability of salmon for river-based recreational fishing opportunities and would be beneficial. Since recreational fisheries would not be adversely impacted under this alternative, and for the reasons described for the Proposed Project, there would be long-term beneficial effects on the scenic quality, recreation, fisheries and wildlife of the California Klamath River wild and scenic river segment and to the resource values of the eligible and suitable wild and scenic river segment under the No Hatchery Alternative (Potential Impact 3.20-7).

4.7.21 Hazards and Hazardous Materials

Full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts related to hazards and hazardous materials as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. Thus, impacts and mitigation measures related to hazards and hazardous materials under the No Hatchery Alternative would be the same as those described in Section 3.21.5 *[Hazards and Hazardous Materials] Potential Impacts and Mitigation*, Potential Impacts 3.21-1 through 3.21-8.

4.7.22 Transportation and Traffic

Full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts related to transportation and traffic as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. However, since there would be no modifications to the Fall Creek Hatchery and no operations for managing the hatcheries, there would be slightly reduced traffic compared with that identified for the Proposed Project. The small degree of difference between the Proposed Project and this alternative would not be sufficient to change the assessment of potential transportation and traffic related impacts, and thus for the reasons described under the Proposed Project, Potential Impacts 3.22-1 through 3.22-5 would continue to be significant and unavoidable and Potential Impact 3.22-6 would be less than significant.

4.7.23 Noise

Full removal of Iron Gate Hatchery under the No Hatchery Alternative would result in a similar degree of construction activities and associated impacts related to noise as the Iron Gate Hatchery modifications (i.e., relocation of fish trapping and holding facilities, relocation of the cold-water supply) and Fall Creek Hatchery upgrades are included under the Proposed Project. However, since there would be no modifications to the Fall Creek Hatchery and no operations for managing the hatcheries, there would be slightly reduced noise compared with that identified under the Proposed Project. The small degree of difference between the Proposed Project and this alternative would not be sufficient to change the assessment of potential noise-related impacts. For the reasons described under the Proposed Project, short-term vibration from blasting at Copco No. 1, Copco No. 2, and Iron Gate dams, and noise from deconstruction activities at Copco No. 1 and Iron Gate dams and restoration activities in the reservoir footprints, would result in significant and unavoidable impacts (Potential Impact 3.23-1 through 3.23-2 and 3.23-4 through 3.23-6). Noise-related impacts at Copco No 2. Dam due to construction-related activities (Potential Impact 3.23-3), traffic noise along haul routes (Potential Impact 3.23-7), moving or elevating structures with flood risk and modification of downstream water intakes (as needed) (Potential Impact 3.23-8), construction associated with modifying water intakes (Potential Impact 3.23-9), and construction activities related to deepening or replacement of existing groundwater wells (Potential Impact 3.23-10) would result in no significant impacts relative to existing conditions, as described for the Proposed Project.

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5 OTHER REQUIRED CEQA DISCUSSION AND CONSIDERATION OF SOCIAL AND ECONOMIC FACTORS

CEQA also requires consideration and discussion of several other enumerated factors, including irreversible and irretrievable commitment of resources, growth inducing impacts, and areas of controversy. Additionally, CEQA provides guidance regarding how to assess potential economic and social changes resulting from a project within the context of determining physical effects on the environment. Each of these topics is considered below.

5.1 Irreversible and Irretrievable Commitment of Resources

CEQA requires a discussion of any significant effect on the environment that would be irreversible if the project were implemented or would result in an irretrievable commitment of resources (CEQA Guidelines Section 15126(c)).

Dam removal, deconstruction, construction, and restoration activities under the Proposed Project and the other dam removal alternatives would involve the consumption of nonrenewable natural resources. These nonrenewable natural resources would consist of fuels necessary to operate equipment used during deconstruction activities. The Proposed Project would include removal of four dams and all power generation facilities. This would result in the generation of waste from the concrete, mechanical, and electrical items at the dams and power facilities. Petroleum-fueled transportation equipment would be used to haul these materials to disposal sites in the project area. In addition to fuels used in transportation, the use of the disposal sites would constitute an irreversible and irretrievable commitment of resources. Concrete and earthen materials would be used as backfill to bury dam structures, backfill the excavated tailrace channels, and restore the river to its pre-dam appearance. These materials would be permanently committed during implementation of the Proposed Project and the other dam removal alternatives. Construction activities necessary for implementation of the Proposed Project would require the use of nonrenewable natural resources including petroleum for fuels and other construction materials.

5.2 Growth Inducing Impacts

CEQA Guidelines Section 15126.2(d) requires an environmental document to:

> *"Discuss the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment. Included in this are projects which would remove obstacles to population growth…."*

Direct growth-inducing impacts generally stem from the construction of new housing, businesses, or infrastructure. Indirect growth inducement could result if a project establishes substantial new permanent employment opportunities or if it would remove obstacles hindering population growth, such as the expansion or the provision of urban services and infrastructure in an undeveloped area. Under CEQA, growth inducement may not necessarily be considered detrimental, beneficial, or of insignificant consequence. Induced growth is considered a significant impact only if it directly (or indirectly) affects the ability of agencies to provide needed public services, or if it can be demonstrated that the potential growth significantly affects the environment.

The Proposed Project would not result in the construction of new housing either directly or indirectly. The Proposed Project would not provide new water, wastewater, sewer, electricity, or natural gas infrastructure or facilities and would not require or create any new public services such as schools, public services, or public roads that could support increased growth in the Klamath Basin.

The Proposed Project and the other dam removal alternatives would likely bring in construction workers to the project vicinity during the construction work period. Any Project-related employment required for the alternatives would be temporary and would be needed only during an approximate 17-month period encompassing demolition activities associated with Copco No. 1, Copco No. 2, and Iron Gate dam developments. Construction worker housing would be temporary during the construction period. See Section 3.16.5 *[Population and Housing] Potential Impacts and Mitigation* for a detailed discussion of this topic. Implementation of the Proposed Project would not generate any permanent employment opportunities that would attract a substantial number of people to the region or create the need for substantial amounts of new housing or services.

Restoration of the Klamath River fisheries is one of the main objectives of the Proposed Project. If the fish populations were to rebound back to pre-dam levels, this could result in an increase in recreational fishing in the region (see Section 3.20.5 *[Recreation] Potential Impacts and Mitigation* for a detailed discussion of this topic) and possibly an increase in overall tourism. Such a change in visitor numbers would likely occur slowly as fish populations rebound, but would be unlikely to result in permanent population growth.

As discussed below in Section 5.4.1.1 *Commercial Fishing*, benefits to the commercial ocean fishery and associated fleets that rely on that fishery could lead to increased regional employment, with ports along the Northern California and Southern Oregon coastlines likely to experience the highest increases. USBR (2012) estimated that under a dam removal scenario, up to 453 full time, part time, or temporary additional jobs would be created in the commercial fishing industry across the five management areas stretching along approximately 600 miles of coastline, from the San Francisco ocean commercial fishing management area to the Central Oregon ocean commercial fishing management area. Given that economic benefits related to increases in the commercial ocean fishery would come in the form of a rebound from historic lows in recent years to levels that previously existed, and estimated job creation would be spread across a region stretching from the San Francisco Bay Area to central Oregon, the increases should not reasonably necessitate new or additional permanent housing, utilities or services in the region. For additional comparative purposes, the Klamath-CA Management Zone, which includes Humboldt and Del Norte Counties, is expected to see an increase of 19 jobs due to the Proposed Project (USBR 2012), or approximately 1 percent of the population growth for that region that is projected to occur between 2020 and 2030 (1,921 people) (California Department of Transportation 2017, Humboldt County 2017).

The Proposed Project and the other dam removal alternatives would not result in new permanent housing, utilities, services, permanent employment, or other growth inducement in the region, nor would the Proposed Project result in any impacts that would require the provision of new permanent housing, utilities, services, or permanent employment. Therefore, the Proposed Project and the other dam removal alternatives would not create growth-inducing impacts.

5.3 Areas of Controversy and Issues Raised by Agencies and the Public

CEQA Guidelines Section 15123 requires disclosure of the controversial project issues known to the Lead Agency, including those raised by agencies and the public. Table ES-2 in the Executive Summary of this EIR presents a summary of controversies raised by agencies and the public during the scoping period and other forums. These are opinions and issues raised by agencies and members of the public and do not necessarily represent the position of the State Water Board.

5.4 Social and Economic Factors Under CEQA

Pursuant to CEQA, lead agencies must analyze potentially significant adverse impacts of a project to the physical environment. The term 'environment' means "*the physical conditions which exist within the area which will be affected by a proposed project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historical or aesthetic significance… The "environment" includes both natural and man-made conditions"* (CEQA Guidelines Section 15360). Under CEQA, potential effects from implementing a project, such as reductions in property values, loss of property tax revenues, and increases in energy costs, that are solely social or economic in nature, would not constitute an effect (i.e., an impact) to the physical environment.

CEQA Guidelines Section 15131 states the following regarding consideration of economic or social factors as part of an EIR:

> *(a) Economic or social effects of a project shall not be treated as significant effects on the environment. An EIR may trace a chain of cause and effect from a proposed decision on a project through anticipated economic or social changes resulting from the project to physical changes caused in turn by the economic or social changes. The intermediate economic or social changes need not be analyzed in any detail greater than necessary to trace the chain of cause and effect. The focus of the analysis shall be on the physical changes.*
>
> *(b) Economic or social effects of a project may be used to determine the significance of physical changes caused by the project…. Where an EIR uses economic or social effects to determine that a physical change is significant, the EIR shall explain the reason for determining that the effect is significant.*
>
> *(c) Economic, social, and particularly housing factors shall be considered by public agencies together with technological and environmental factors in deciding whether changes in a project are feasible to reduce or avoid the significant effects on the environment identified in the EIR. If information on these factors is not contained in the EIR, the information must be added to the record in some other manner to allow the agency to consider the factors in reaching a decision on the project.*

5.4.1 Consideration of Economic Information for Resources Potentially Affected by Dam Removal

Economic studies completed in 2011−2012 by USBR (2012) and DOI (Real Estate Sub-team 2012) for removal of the four dams and alternatives considered likely costs and benefits for a number of topics, including the following:

- Hydroelectric energy costs
- Irrigated agriculture
- Commercial fishing
- In-river recreational fishing
- Ocean sport fishing
- Refuge recreation
- Nonuse values
- Real estate

The USBR/DOI economic studies determined direct dam removal costs from deconstruction, construction, operations, maintenance, and replacement, as well as forgone costs to hydropower, reservoir recreation, and whitewater recreation. Benefits were identified for irrigated agriculture, commercial fishing, ocean sport fishing, in-river sport fishing, tribal fisheries and cultural values, refuge recreation, nonuse values (e.g., desire to preserve ecosystems, altruism towards plants and animals), and real estate. Benefits to tribal fisheries and cultural values, the wildlife viewing component of refuge recreation, and real estate were not quantified in economic terms in USBR (2012). Potential economic impacts on real estate were discussed in a separate report (Real Estate Sub Team 2012).

Of the topics from the 2012 studies, several of the analyses are not relevant to the Proposed Project (i.e., irrigated agriculture, refuge recreation, nonuse values) because the prior studies related to implementation of the Klamath Basin Restoration Agreement (KBRA) (see Section 2.6.3 *Klamath Settlement Agreements*). Under the 2012 analysis, implementation of the KBRA was a “connected action” to dam removal and inclusion of the KBRA is an inherent assumption of the prior economic analyses. Other topics (i.e., hydroelectric energy costs [see Section 3.10 *Greenhouse Gas Emissions*], in-river recreational fishing [see Section 3.20 *Recreation*]) are analyzed in this EIR by focusing on physical changes that would occur as a result of the Proposed Project and the alternatives, and, consistent with CEQA Guidelines Section 15131(b), the results of the previous economic analyses are not required to determine if a physical change to the environment would be significant.

The prior economic studies of potential commercial fishing effects from dam removal is relevant to this EIR, since Proposed Project Objective 2 (see Section 2.1 *Project Objectives*) focuses on advancing the long-term restoration of the natural fish populations in the Klamath Basin, including commercial fisheries. The results of the USBR/DOI prior economic studies for commercial fishing are summarized below in Section 5.4.1.1 *Commercial Fishing*. Although this EIR focuses on the analysis of potential impacts to in-river recreational fishing under the Proposed Project (see Section 3.20 *Recreation*), the prior economic analysis of ocean sport fishing is summarized below in Section 5.4.1.2 *Ocean Sport Fishing* to provide broader context for possible increased recreational fishing opportunities given dam removal. Lastly, as noted in

Table ES-2, the State Water Board received several comments during the NOP public scoping process regarding the potential for regional economic impacts of the Proposed Project, including comments from the Pacific Coast Federation of Fishermen's associations and the Institute for Fisheries Resources, estimating economic benefits from restored fisheries, and comments from the Siskiyou County Assessor-Recorder regarding reductions in property values and the loss of property tax revenues. The results of the DOI's prior economic studies for real estate and the concerns from the Siskiyou County Assessor-Recorder are summarized below in Section 5.4.1.3 *Real Estate and Property Taxes*.

5.4.1.1 Commercial Fishing

The commercial ocean salmon fleets that rely on the affected ocean commercial fishery consist largely of small, independently owned and operated trollers[232] that land (i.e., catch) salmon south of Cape Falcon, Oregon. The fishery is a mixed stock fishery, where the commercial harvest includes salmon stocks from different rivers, including Southern Oregon/Northern California Coast (SONCC) coho and Klamath River fall- and spring-run Chinook salmon (see also Section 3.3.2.1 *Aquatic Species – Anadromous Salmonids*). The Pacific Fisheries Management Council (PFMC) manages the salmon fishery on the basis of "weak stock management," whereby regulations are designed to protect weaker stocks, even if that means foregoing some harvest of the healthier stocks that comingle with the weaker ones in the ocean commercial fishery. For purposes of this discussion the primary implications of weak stock management as it relates to SONCC coho and Klamath Chinook salmon are as follows (NMFS 2012).

- PFMC-managed ocean fisheries south of Cape Falcon are subject to consultation standards for two Chinook and four coho salmon Evolutionarily Significant Units (ESUs) listed under the Endangered Species Act (ESA), including the SONCC coho ESU (listed in 1997). To meet consultation standards for the coho ESUs, the PFMC has banned coho retention (i.e., catching and keeping or retaining individuals) in the troll fishery in Klamath Management Zone in California (KMZ-CA) and in Oregon (KMZ-OR) since 1990 and in all other management areas south of Cape Falcon since 1993 (with the exception of limited fisheries in 2007 and 2009 in Central and Northern Oregon).
- The major salmon stocks targeted by ocean fisheries south of Cape Falcon are Sacramento River fall Chinook and Klamath River fall Chinook salmon. For most of the past three decades, Klamath River fall Chinook has been more constraining on the troll fishery than Sacramento River fall Chinook. Because Sacramento River fall Chinook and Klamath River fall Chinook intermix in the troll harvest, regulations devised to limit harvest of Klamath River fall Chinook necessarily constrain Sacramento River fall Chinook harvest as well to levels below what would have been allowed in the absence of the Klamath River fall Chinook constraint.

Coastal ocean fishing-dependent communities have suffered severe economic impacts due to decreases in fish numbers and related harvest limitations. USBR (2012) identified that the removal of four dams and facilities would result in notable positive regional economic benefits to commercial troll fishing of SONCC coho and Klamath

[232] Trolling is a method of fishing where one or more fishing lines, baited with lures or bait fish, are drawn by a vessel through the ocean surface waters (or at a certain depth) to catch individual fish.

River fall- and spring-run Chinook salmon. The ocean migratory range of these species is mostly south of Cape Falcon, Oregon, and includes the Northern Oregon, Central Oregon, Klamath Management Zone (KMZ-OR and KMZ-CA), Fort Bragg, San Francisco, and Monterey management areas. The KMZ-CA (Oregon-California state line to Horse Mountain) falls within the Area of Analysis for aquatic resources in this EIR (Figure 3.3-1). Within these areas, USBR (2012) considered the effects on the SONCC coho ESU qualitatively through the increase in viability of the Klamath River coho populations. USBR (2012) reported that the removal of the dams and associated facilities would likely increase the viability of the SONCC coho ESU in the Klamath Basin, but would be unlikely to lead to de-listing of the ESU as a whole and thus they considered that coho retention would likely continue to be prohibited. Following dam removal, harvests would be larger because of increased abundance of salmon, which would, in turn, increase commercial fishing revenues.

The USBR (2012) quantitative economic analysis relied heavily on the Evaluation of Dam Removal and Restoration of Anadromy (EDRRA) model, using the average annual Klamath Chinook troll harvest for the period 2001 to 2005 (35,778 fish) as a measure of the existing condition, where this average was also applied by NMFS (2012) to assess the effects on fall- and spring-run Chinook salmon over fifty years. The EDRRA model accounted for the requirement to reserve 50 percent of the Klamath-Trinity River salmon for the Yurok and Hoopa Valley Tribes, where this requirement has been in effect since 1993 (DOI 1993), with the remaining 50 percent allocated to the in-river recreational fishery (7.5 percent), ocean sport fishery (8.5 percent), and ocean commercial fishery (34 percent) (NMFS 2012). The EDRRA model allowed for area-specific estimates of troll harvest and net revenue (gross revenue minus trip expenses) for various alternatives in the Klamath Basin, including a “No Project Alternative” and the removal of the four dams and facilities. In addition to the EDRRA model analysis of Chinook escapement and harvest, the following considerations were part of USBR’s (2012) economic evaluation, based on information from Hamilton et al. (2011), Lindley and Davis (2011), and Goodman et al. (2011):

- Partial or full dam and facilities removal would provide habitat (coldwater tributaries and thermal refugia) favorable to spring-run Chinook salmon;
- Viable populations of spring-run Chinook salmon in the Upper Klamath Basin would improve the sustainability of the ESU;
- Removal of the four dams and associated facilities offers greater potential for increased harvest and escapement of Klamath Chinook salmon than current conditions, and the potential for positive benefits is greater for the fall-run than for spring-run Chinook salmon.

Primarily using the EDRRA model, and dependent on the management area, dam and facilities removal was estimated by USBR (2012) to provide an additional 11 to 218 commercial fishing industry jobs within the five management areas, an increase of labor income between $0.06 million to $2.56 million, and an economic output of $0.13 million to $6.6 million (all 42 to 43 percent increases) for commercial fishing compared with the status quo (see Table V-4 in NMFS 2012). The average annual increase in net revenue for all areas modeled with removal of the dams and associated facilities would be $7.296 million (43 percent increase), and ocean commercial fishery benefits for 2012 to 2061 were estimated to be $134.5 million (discounted to 2012 value). The KMZ-CA portion of this annual net revenue benefit was estimated to be $267,131 (2012 dollars).

Overall, the prior economic studies concluded that commercial troll fishery harvests of SONCC coho and Klamath River fall- and spring-run Chinook salmon would increase over existing conditions due to an increased abundance of salmon resulting from dam removal. For the reasons discussed in this EIR in Section 3.3.5 *Aquatic Resource Impacts*, the KRRC's Proposed Project would be beneficial for populations of fall-run Chinook salmon (Potential Impact 3.3-7), spring-run Chinook salmon (Potential Impact 3.3-8), and coho salmon (Potential Impact 3.3-9). Although some aspects of the KRRC's Proposed Project are different from the dam removal scenarios analyzed in the USBR/DOI economic analyses, the primary assumptions regarding the effects of dam removal on coho and Chinook salmon have remained the same, such that the prior economic indication of the benefits of dam removal to commercial fisheries also informs consideration in this EIR that dam removal would advance the long-term restoration of natural fish populations in the Klamath Basin, including having a significant beneficial effect on commercial fisheries and an associated significant beneficial economic impact on the coastal commercial fishing industry.

5.4.1.2 Ocean Sport Fishing

In addition to providing in-river recreational fishing opportunities, salmon support an ocean sport fishery. Based on prior economic studies, sport fishing of the SONCC coho ESU and the Klamath River fall- and spring-run Chinook salmon could economically benefit from the removal of the four dams and associated facilities. Although there would be a substantial economic benefit to the SONCC coho ESU, USBR (2012) determined that it would be unlikely to lead to de-listing from 'threatened' under the ESA. Using the EDRRA model (described for commercial fisheries above), the average combined annual net economic value of the ocean recreational Chinook salmon harvest (all stocks) attributable to Klamath Chinook salmon was modeled to increase from $6.415 million under the "No Project Alternative" to $9.159 million following the removal of the four dams and associated facilities (43 percent increase). With the removal of the four dams and associated facilities, this would equate to an increase in the net economic value for the period 2012 to 2061 (discounted to present value) of $50.5 million in excess of the "No Project Alternative." Potential for increases in the harvest of spring- and fall-run Chinook salmon were also identified, with timing of migrations meaning that an increase in fall-run Chinook salmon abundance would be more likely to be advantageous to the ocean recreational fishery (USBR 2012). Overall, the prior economic studies concluded that ocean sport fishing of SONCC coho and Klamath River fall- and spring-run Chinook salmon would increase over existing conditions due to an increased abundance of salmon resulting from dam removal. This finding is generally consistent with the discussion in this EIR in Section 3.20.5 *[Recreation] Potential Impacts and Mitigation* that the KRRC's Proposed Project would benefit in-river recreational fishing opportunities in the long term (Potential Impact 3.20-6), although the aforementioned projected economic effects on ocean sport fishing are not required to support the significance determination for in-river recreational fishing.

5.4.1.3 Real Estate and Property Taxes

Removal of the four dams and their reservoirs could affect real estate values of parcels surrounding Copco No. 1 and Iron Gate reservoirs, and parcels adjacent to the Klamath River downstream of Iron Gate Dam. In prior studies, the outcome of the regional economic real estate analysis was complex indicating that there would be both positive and negative local value changes as a result of dam removal. Dam removal represented only one factor driving the value changes, while local circumstances and ongoing economic trends also had a major influence on predicted values (USBR 2012, Real Estate Sub-team 2012). USBR (2012) qualitatively assessed dam removal based on net economic benefits associated with various resources, and found that removal of the four dams and facilities could result in short-term declines in real estate values, which would be partially offset as the barren landscape is revegetated. USBR (2012) indicated that for some parcels that are currently adjacent to the reservoirs, loss of reservoir frontage may have a permanent adverse effect on their values. For other parcels downstream of Iron Gate Dam, USBR (2012) indicated that improvements of water quality could lead to increased real estate values in the long term. Additional details regarding the USBR (2012) and Real Estate Sub-team (2012) studies are provided below, along with a discussion of Siskiyou County Assessor-Recorder scoping comments on the Lower Klamath Project, as applicable.

The Siskiyou County Assessor-Recorder provided comments during the Lower Klamath Project scoping period (see Appendix A) expressing their view that the prior assessment on property values and tax revenues under a dam removal scenario was deficient. In their comment letter, the County Assessor-Recorder provided their assessment that PacifiCorp's assets (total $162.6 million) would be greatly reduced (by $32.5 million in value) by removal of the dams and associated infrastructure, resulting in a loss of approximately $370,000 per year in taxes for Siskiyou County, in addition to financial effects on the Hornbrook Elementary School District. While the assumptions used to arrive at the numbers in the USBR real estate reports are explained in the text of these reports, both viewpoints suggest that the County would lose some tax revenue from the removal of the dams.

The Siskiyou County Assessor-Recorder expressed concerns that while the USBR (2012) appraisal considered nearly 1,500 Potentially Impacted Parcels (PIPs) as part of their analysis, they determined that the number of parcels that could be impacted was only 700 Impacted Parcels (IPs). The County Assessor-Recorder also expressed their concern that the approach by USBR (2012) understates the reduction in appraised value and that structural and site improvements, the largest portion of a property's value, were excluded from the appraisals.

The Real Estate Sub-team (2012) Report provided the below reasoning for determining the numbers of PIPs and IPs:

> *"Based on the field inspection, it was determined that those parcels on the near side of the ridgeline were determined to have potential impacts and therefore were included in the parcel list. Those parcels on the far side (backside of the ridgeline) had limited to no views (no lake views), limited access to the reservoirs, and appeared to be larger parcels. It was concluded that these parcels would not be significantly impacted by the dam removals (any influence could not be reliably measured); therefore they were not included on the PIP list."*

The Real Estate Sub-team (2012) Report also stated that the purpose of the study was *"…to determine the impacts to the value of the real property of those parcels that align and/or are influenced by the reservoirs that have formed behind the three identified dams. This study is from a macro perspective, to wit, it is designed to look at the financial impacts, in the aggregate, it is not an analysis of an impact to any given parcel or property. It was determined that the primary value influences or enhancements to* *parcels attributable to the reservoirs include water-frontage and reservoir views. Since these value influences or enhancements are directly attributable to the land component of the real property interest and not to the improvement component it was determined that it would be unnecessary to evaluate the combined house/lot interest."*

Further, the Real Estate Sub-team (2012) Report stated the following:

> *"No building improvements are included in the analysis although approximately 12 percent of the parcels on the impacted parcel list, according to the assessor, have improvements."*

As reported in Real Estate Sub-team (2012), Figure 3.14-3 indicates the number of vacant properties (88 percent of the PIPs) that have not been developed since the surrounding subdivisions were recorded, noting that many of the lots are not ideal for building on and instead are used by owners for camping, and that the remoteness of location, limited access and high utility connection costs were also factored into the analysis. The remaining 12 percent "have land use indicating development (land is improved based on assessed value)". The Real Estate Sub Team (2012) identified 668 parcels that were likely to be negatively affected (i.e., de-valued) as a result of dam removal, and differentiated these parcels into the following three categories:

- Parcels with a view of Iron Gate Reservoir
- Parcels with a partial view of Copco Reservoir
- Parcels with Copco Reservoir Frontage/Access

Table 5.4-1 differentiates the 668 parcels by type of use, of which 127 parcels are used by single-family residences. Table 5.4-2 indicates that less than one-third of the single-family homes in the area are occupied by primary residents.

Table 5.4-1. Land Use Breakdown.

Land Use	No. of Impacted Parcels
Vacant Commercial	2
Commercial	5
Rural (20-acre minimum)	3
Vacant Rural Land (20-acre minimum)	13
Single Family Residence	127
Vacant Residential Land	518
Total Parcels	**668**

Source: Real Estate Sub-team 2012

Table 5.4-2. Single-family Homes on Copco No. 1 and Iron Gate Reservoirs.

	Single Family Residences (SRFs)	SRFs Serving as Primary Residences	Percent Primary Residents
Partial View of Copco Reservoir	40	11	28 percent
Partial View of Iron Gate Reservoir	13	5	38 percent
Copco Reservoir Frontage/Access	74	23	31 percent
Total	**127**	**39**	**31 percent**

With regard to concerns of diminishing property value as a result of the Proposed Project, confirmation of the property value effect is difficult because many variables, (including market conditions, number of distressed sales, buyer resistance) can affect the sale price of a residence (Bender and Rosenthal 2011). In the appraisal process, the Real Estate Sub-team (2012) looked at comparable units which had sold in a similar area of the development. The actual property value effect on housing units cannot be known until the first unit is sold after implementation of the Proposed Project, should this project occur. However, as described below, the Real Estate Sub Team (2012) Report notes that the effect of the Proposed Project on property values would not necessarily only be negative, but may be mixed.

Further, the amount of property tax that municipalities, school districts, and fire districts receive from the State fluctuates over time due to a number of factors in addition to property values. Some of the most significant factors that affect local revenue-raising include (ILG 2016):

- The allocation of local property tax among a county, and cities, special districts and school districts within each county is controlled by the Legislature.
- Property taxes may not be increased except with a two-thirds vote to fund a general obligation bond.
- Voter approval is required prior to enacting, increasing or extending any type of local tax.
- Assessments to pay for public facilities that benefit real property require property owner approval.

The Siskiyou County Assessor-Recorder scoping comments also expressed their view that the prior studies ignored the perception that with removal of the dams, property values for residents downstream of Iron Gate Dam would drop because people believe that they will be subject to additional flooding as a result of the removal of the dams. The County asserted in their comment letter that "*Perception is reality when it comes to property values*". The Real Estate Sub Team (2012) Report notes that dam removal would reduce or eliminate many of the effects of poor water quality in the river (e.g., extensive algae mats, odors and algal toxins), which could increase values for downstream properties located adjacent to the river, and that more robust runs of anadromous fish could also increase property value. The potential effects of the Proposed Project on flood risk, water quality, and fisheries, are robustly considered in this EIR by analyzing those specific resource topics in Section 3.6 *Flood Hydrology*, Section 3.2 *Water Quality*, and Section 3.3 *Aquatic Resources*.

Under CEQA, potential effects from implementing a project, such as reductions in property values, loss of property tax revenues, and increases in energy costs, that are solely social or economic in nature, would not constitute an effect (i.e., an impact) to the physical environment and are not further analyzed in this EIR. While Siskiyou County currently receives tax revenues from PacifiCorp for hydroelectric power generation at the Lower Klamath Project, it would be expected that these revenues would cease. This would result in a lowering of County tax revenues for operation of County government.

Under the Proposed Project, if Parcel B lands were operated as income-producing wildlife management areas after being transferred to the State then California Fish and Game Code section 1504 would apply. Subdivision (a) of section 1504 states:

> *When income is derived directly from real property acquired and operated by the State as wildlife management areas, and regardless of whether income is derived from property acquired after October 1, 1949, the department shall pay annually to the county in which the property is located an amount equal to the county taxes levied upon the property at the time title to the property was transferred to the State. The department shall also pay the assessments levied upon the property by any irrigation, drainage, or reclamation district.*

5.4.2 Consistency Under CEQA With Respect to Consideration of Economic or Social Factors

According to Section 15131(a), socioeconomic effects themselves are not required to be discussed under CEQA, but rather discussion should be focused on any physical changes that would occur as a result of such effects. If the resulting physical changes are reasonably foreseeable and significant, then the conclusion that there would be an impact is supported; otherwise it is speculative. Additionally, under Section 15131(b), economic or social effects may be used as a rationale to determine if any physical change to the environment is significant. The prior economic studies conducted by USBR and DOI for removal of the four dams and alternatives did not identify reasonably foreseeable physical impacts that could occur as a result of anticipated economic effects due to dam removal, nor did the 2012 KHSA EIS/EIR that relied upon those studies. Additionally, during scoping the public did not raise any substantial concerns that the potential economic or social changes resulting from the Proposed Project would, by themselves, result in significant adverse physical changes to the environment separate from any impacts already identified by the analyses. Based on subsequent review of the prior economic studies for preparation of this EIR (see Section 5.4.1 *Prior Economic Studies for the Klamath Basin Dam Removal*), there would be economic benefits to commercial fisheries that could lead to physical changes to the environment. While increased commercial fish catch could impact the ocean environment near the Klamath River mouth and result in the need for additional infrastructure onshore, because the potential environmental effects associated with a long-term increase in commercial harvests are speculative, and would be subject to local or other regulations, they are not considered further.

Additionally, the concerns and issues raised by the public during the NOP scoping process (Section 5.3 *Controversies and Issues Raised by Agencies and the Public*) do not provide substantial evidence that potential economic changes or social changes resulting from the Proposed Project would, by themselves, result in significant adverse physical changes to the environment separate from any impacts already identified by the analyses. Where the potential for socioeconomic effects has been raised, the effects have themselves been speculative, and while these remain speculative, so would the potential for any resulting physical impacts to the environment.

Having considered CEQA Guidelines Sections 15131(a) and (b), reasonably foreseeable physical environmental effects of the Proposed Project and alternatives (e.g., transformation of reservoirs into a free-flowing river, downstream transport of reservoir sediment deposits, alterations in the 100-year floodplain, changes in seasonal water temperatures in the Klamath River) have been rigorously assessed in this EIR using significance criteria that directly reflect the characteristics of the associated environmental resource being analyzed. Further, a number of potential environmental effects of the Proposed Project and alternatives that could have related socioeconomic effects (e.g., unplanned population growth, displacement of existing people or housing necessitating the construction of replacement housing, changes in connectivity between areas of a community, conversion of agricultural or forest lands) also have been rigorously assessed in this EIR using significance criteria that directly reflect the characteristics of the associated environmental resource being analyzed, such that a separate social or economic analysis is not required, consistent with Section 15131(b).

According to Section 15131(c), consideration of appropriate mitigation measures and/or alternatives to a project should include an assessment of whether there are any socioeconomic effects that would render the proposed measures or alternatives infeasible, such that they would not avoid significant adverse physical changes to the environment. Consideration of potential economic impacts of Lower Klamath Project mitigation measures and alternatives to the Proposed Project was undertaken throughout EIR preparation. For example, the physical removal of reservoir bottom sediments prior to drawdown (i.e., dredging) was deemed to be infeasible, in part due to the high cost of this approach (Lynch 2011) and thus cannot serve as mitigation for short-term increases in suspended sediment concentrations due to dam removal. Section 4 *Alternatives* also presents a discussion of the selection of feasible alternatives that includes consideration of the cost of implementing project alternatives.

Note that a number of impacts have been identified as significant and unavoidable under the Proposed Project, because mitigation is infeasible due to preemption of the Federal Power Act over state authority (see Section 2.8 *Intended Uses of the EIR*) rather than for socioeconomic reasons.

In summary, this EIR is consistent with CEQA Guidelines Section 15131 regarding consideration of economic or social factors associated with a project. The use of potential economic or social effects of the Proposed Project to determine the significance of physical changes caused by the project is unnecessary given that the significance criteria used in this EIR directly reflect the characteristics of the associated environmental resource being analyzed, and any other potential physical changes are speculative. Lastly, consideration of potential economic impacts of Lower Klamath Project mitigation measures and alternatives to the Proposed Project has been undertaken throughout this EIR.

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